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COTTON HANDLING GUIDE
for
Warehouse Managers and Foremen

UNITED STATES DEPARTMENT OF AGRICULTURE
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PREFACE

This publication reports part of a broad research project, covering materials handling, which is under the general supervision of William H. Elliott, staff assistant for marketing-facility and materials-handling research, Marketing and Facilities Research Branch of the Production and Marketing Administration.

The authors thank the many cotton warehousemen who made their plants available for time studies, methods analyses, and for general observation and study of their cotton handling operations. Many persons directly or indirectly contributed toward this report.

Acknowledgment is made to other writers in the general fields of methods improvement and materials handling. In this connection special credit is due to Harry E. Stocker, Curtis H. Barker, Jr., Irving M. Footlik, Charles F. Yarham, V. Francis Carle, L. P. Alford, John R. Bangs, and John R. Immer, some of whose statements of materials-handling principles are closely paralleled by those of some of the cotton-handling principles set forth in this publication.

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SUMMARY

Research by the Department of Agriculture in the handling of baled cotton--in connection with which studies of handling operations have been made at many compresses and warehouses throughout the Cotton Belt--has revealed that despite many notable improvements in cotton handling resulting from the increased use within the last few years of new types of mechanical equipment and of improved or more efficient methods discovered or developed through research or other means, inefficiencies in handling cotton are still widespread. Most of the inefficiencies probably could be reduced or eliminated if warehouse managers, superintendents, foremen, or others responsible for handling operations were shown how to analyze their own operations systematically to find and remove the causes of inefficiencies.

Through the same kind of analysis, new or improved handling methods could often be developed by the warehousemen themselves.

The purpose of this report is to outline to cotton warehousemen a few suggestions as to how more efficient methods for handling cotton may be devised or discovered, and to list and briefly discuss some broad principles of materials handling, which, when applied to the warehousing of cotton, should result in increasing handling efficiency and in reducing handling costs.

Most inefficiencies in the handling of cotton result from one or more of the following reasons: (1) Failure to use suitable powered handling equipment in place of manual labor; (2) failure to make proper and effective use of such equipment when it is employed; and (3) failure to make effective use of the manual labor employed.

To eliminate or reduce such inefficiencies it is necessary to examine handling operations with a view toward finding out how the inefficiencies came about, in order to remove the sources of trouble. In examining handling operations, one essential is a questioning attitude, which refuses to take anything for granted or to accept any practice as correct merely because it has been followed for a long time.

Each operation or method examined should be subjected to careful scrutiny and to the searchlight of such questions as:

1. What is done -- what is the purpose?
2. Why is it done -- is it necessary?
3. Who does it -- could another person do it better or at less cost?
4. Where is it done -- would another place be better?
5. When is it done -- would another time be better?
6. How is it done -- could it be done another way more cheaply?

After the answers to the above questions have been carefully considered, means of improving the operation or method along the following lines should be explored.

Can the operation, or any part of it, be:

1. Eliminated?
2. Combined, to advantage, with another operation?
3. Separated, to advantage, from another operation?
4. Placed in a better sequence?
5. Simplified?

In making changes in operations or methods, which may be suggested by these analyses of esisting methods, or in organizing and integrating the handling of cotton throughout the warehouse, the basic principles of economic and efficient handling (of which 19 principles are listed and discussed) should be considered.

Applications to cotton handling of the techniques recommended for the analysis and improvement of handling methods, and of the basic principles of materials handling, may be illustrated by examples drawn from research. In some instances, small to large savings may be obtained by simple changes in methods or equipment made at nominal cost or perhaps at no cost at all. For example: (1) At one warehouse a change in the procedure for positioning bales in the dinky press eliminated a pull-down man; (2) at another warehouse a change in the procedure for placing bales in a cordwood stack resulted in eliminating 1 worker from the 4-man crew originally used; (3) the simple device of shifting the location of the buck bar at the main press to a point within radius of the jib crane saved 2 men who hand trucked newly compressed bales from the press to the buck bar; (4) conversion of a standard beam scale to a mobile beam scale makes possible the elimination of all hand truckers used in weighing flat bales; (5) proper integration of the <u>transporting</u> phases of two or more otherwise independent operations may result in substantially lower costs for these operations; (6) the use of temporary blocks (groups of bales in temporary storage between the operations in a cycle) to separate from each other the unloading, weighing, sampling, and transporting-to-storage operations in a receiving cycle may make possible the reduction of receiving costs by 20 percent or more even though relatively less efficient manual-hand-truck methods are retained.

In other instances, as indicated by research, larger savings in labor costs may be obtained by substituting machine methods for manual methods. For example: (1) A single 2-bale clamp truck may, when used to <u>unload</u> a railroad car, perform work equivalent to that of 6 or more manual workers; (2) when used to <u>load</u> a car, or to stack cotton, it may do the work of 10 or more workers; (3) when used to load or unload tractor-trailer trains, it may do the work of 3 to 8 (and in some situations considerably more) workers; (4) when used for transporting, it may do the job of 4 or more hand truckers. Machines of larger capacity, capable of handling 3, 4, 6, 9, or more bales, are able to effect correspondingly larger savings in manpower. In most situations in which powered equipment has been used, the savings in labor have been much more than enough to cover the costs of owning and using the equipment.

COTTON HANDLING GUIDE FOR WAREHOUSE MANAGERS AND FOREMEN

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INTRODUCTION

Studies and observations at cotton warehouses and compresses of almost all types have shown that in nearly all of these facilities many opportunities exist for increasing the efficiency of handling methods. Moreover, there is much evidence to indicate that in most warehouses the savings that might be made through the improvement of handling methods, or through the reduction or elimination of wasted or idle labor in handling cotton, are very large. Some of the savings already obtained by warehousemen through adoption of improved handling methods, either as a result of recommendations based on the Department's research, or on their own initiative, have proved substantial. As more efficient handling methods are adopted, and as their use is further extended throughout the cotton warehouse industry, the greater the total savings in handling costs that will be achieved. In the long run, the savings derived from increasing the efficiency of cotton warehouse handling operations should tend to result in increased benefits not only to cotton warehousemen but also to producers, shippers, mills and other segments of the cotton industry, and to the consumers of cotton products.

Contacts with superintendents and foremen also have indicated that, if the solution of materials-handling problems were approached in a systematic manner, most supervisors could determine for themselves where their bale-handling methods are at fault, and they could accomplish many improvements in their handling operations which would reduce inefficiencies and handling costs. It is likely that they need little more than some assistance or guidance in tackling the problem.

The purpose of this report is to provide some measure of guidance to those cotton warehousemen who would like, through their own efforts or through their own study and analysis of handling problems and operations, to find ways of improving their handling methods. This publication was designed to help those cotton warehousemen who wish to help themselves. It outlines certain broad principles of materials handling

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1/ Alan W. Steinberg was formerly with the Production and Marketing Administration.

and methods improvement which warehouse managers or supervisors can apply, and interprets these principles in terms of handling bales of cotton.

This publication does not pretend to make materials-handling specialists out of cotton warehousemen who may read it. It does recognize that a great many, if not most, improvements in cotton handling could be made by nonspecialists through careful observation to detect trouble spots, and through the application of common-sense. Many mechanical devices currently used to great advantage in handling cotton--for example, the cotton clamp attachment for industrial lift trucks--and many improvements in the use of commercially designed equipment were originated or developed by workers in the cotton warehouse industry. It is hoped that this report may be of assistance in further encouraging the development of improved handling methods and equipment by supervisors and others close to the job--the ones who are, in fact, best equipped to do it.

INTEREST OF MANAGEMENT IN INCREASING EFFICIENCY OF HANDLING OPERATIONS

Increased operating efficiency, or the reduction of operating costs, is a goal toward which the efforts of plant managers should be constantly directed. This goal is as desirable in the cotton warehouse industry as it is in any other industry.

Handling Costs a Major Concern of Cotton Warehousemen

In at least one respect, the cotton warehouse industry differs from most other industries. The kinds of costs involved in the operation of a cotton compress or warehouse and, consequently, the kinds of opportunities that exist for the application of cost reduction methods, are more limited in range than those in manufacturing and processing industries. This limitation does not mean that the warehouseman's costs are necessarily of less importance or smaller in size than are those of a manufacturer doing a comparable amount of business. It does mean that the costs are of a more specialized character. Where most manufacturers or processors may be concerned primarily with such problems as purchasing procedures, machine design, materials control, and production planning, the cotton warehouseman is usually concerned very little or not at all with such problems, since he is engaged solely in performing services.

Although the warehouseman who operates a cotton compress may change the size, shape, or appearance of a bale, he does not manufacture anything from the bale. Therefore, the warehouseman is not concerned with manufacturing or processing costs. However, like the manufacturer or processor, but to a much greater degree relative to other costs, the warehouseman is concerned with physical handling costs.

Foremost among the services provided by a cotton warehouseman is the storage of cotton. Incidental to storage, and to most other services available in a cotton compress or warehouse, a great deal of physical handling of bales is involved. Bales received at a warehouse must be unloaded from, and later reloaded into, railroad cars or motortrucks. The bales also are weighed, sampled, transported a number of times, placed in storage, and broken out of storage.

What the Term "Materials Handling" Means

All these activities involve physical handling. Such physical handling primarily consists of the horizontal and vertical movement of bales into, within, and out of the warehouse. This type of handling or movement, whether of bales of cotton or other products and materials, or whether within a manufacturing, processing, or warehousing facility, is known among industrial engineers as materials handling.

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Although the term "materials handling" may be defined in a slightly different way, most definitions include the picking up, moving, and setting down of materials. Also, most definitions regard storage, as well as movement to and from storage, as a materials-handling function. If materials handling essentially involves movement of some kind, the inclusion of storage itself as a type of materials handling may appear to be somewhat paradoxical. In this connection, however, materials-handling specialists have pointed out that although storage may not represent movement through space, it does represent movement through time. For purposes of this report, storage as well as the physical movement of cotton within a warehouse is considered to be a phase of materials handling.

Some Basic Terms

The terms basic to any discussion of methods improvement are defined under this heading. Other terms are defined as they occur in this publication.

Operation

Cotton is received and placed in storage at a warehouse, and later broken out of storage and shipped, by being moved through a series of handling operations. Each operation involves a sequence of acts or of groups of motions necessary to the accomplishment of a particular handling objective. For example, the cutting, pulling, trimming, and rolling or wrapping of samples from bales of cotton represent part of a sequence of acts which make up the operation commonly known as sampling. The object is to take from each bale a sample to be used as a basis for evaluating the quality of the bale. The sample must be taken in a prescribed manner, and prepared so that it may be used by the owner in selling the bale. Some of the most common operations involved in the warehousing of cotton are unloading from railroad cars and motortrucks, weighing, sampling, transporting, storing, breaking storage, and loading onto railroad cars and motortrucks.

Element

Each of the acts forming a component part of an operation, such as those indicated above for sampling, may be described as an elemental operation, or simply an element. An element is nothing more than a small operation which is an identifiable part of a larger operation. It consists of a motion or group of motions representing a particular subdivision of the operation which it is practical to study--and to time--separately. The time required to perform any single element is known as an elemental time. The subdividing of an operation into a number of smaller operations or elements is useful in analyzing the larger operation and for detecting within it opportunities for improving the method employed.

Cycle

The time required to perform all the elements of an operation upon a single unit of product--such as a single bale of cotton--is known as cycle time or simply as a cycle. A series of full operations necessary to complete a process, as for example those involved in receiving cotton, may also be described as a cycle.

Method

An operation is performed through combining labor and equipment. An industrial lift truck and driver may be combined, or used together, to perform the operation of loading a railroad car. A group of workers may be used in particular ways with certain types of equipment to perform, for example, the operation of breaking bales out of storage. The terms "handling method" and "work method" (shortened to method) refer to the particular way in which materials-handling equipment and labor are combined for use in performing a specific operation or a group of related operations.

Different methods for performing a given operation may result in different labor requirements, and in different costs, for the operation. Differences in labor requirements or in costs--which are not necessarily the same thing--tend to reflect differences in the efficiency of the methods under comparison.

Efficiency

The term "efficiency," when used in different connections, sometimes has slightly different meanings. However, it is most often used to express the relationship between input and output in an operation or process. In handling bales of cotton, this relationship might be expressed as the man-hours of labor required to handle, for example, 100 bales. Throughout this discussion the term efficiency will mean the relationship between the volume of bales handled in an operation and the man-hours of labor required to handle them. The efficiency of an operation is increased when, through some change in the procedure employed, a greater productivity of labor is obtained. The productivity of labor may be increased by eliminating or reducing idle labor or wasted effort, or by making more effective use of labor, such as by using it in conjunction with mechanical equipment.

In comparing the efficiency of two or more methods of performing an operation, it may be convenient at times to think of this relationship in one of two different ways. For example, methods may be compared for efficiency by noting either: (1) The labor requirements or input of each method for handling an equivalent number of bales; or (2) the number of bales that may be handled under each method at a specified expenditure or input of labor. These are simply two ways of looking at exactly the same thing. However, in comparing methods it is sometimes simpler to use one rather than the other view.

In operations in which labor is the predominant factor, an improvement in efficiency, if obtained solely through reducing the requirements for labor, will result in lower costs. If the efficiency has been obtained through the addition of equipment not previously used in the operation, the cost of using the new equipment must be considered together with the cost of labor to determine the total cost. Thus, when equipment is added it is possible for an improvement in labor efficiency to result in a higher, rather than a lower, cost. However, the relationship is usually the opposite. Where the use of mechanical equipment is appropriate, its use ordinarily results in greatly reduced costs. Since a cotton warehouseman is likely to be more interested in whether a money saving has been obtained by an improved method than in the amount of labor saved, the cost factor will be covered whenever its nature is not otherwise clear from the discussion.

NEED FOR IMPROVEMENT OF HANDLING METHODS IN COTTON WAREHOUSES

Despite Increased Mechanization Many Handling Inefficiencies Still Found

The abundance of relatively inexpensive labor available to the cotton warehouse industry until recent years, has definitely influenced the physical characteristics of warehouse facilities, the types of handling equipment used, and the work methods for handling cotton. Recently, however, with rising wage rates in almost all areas and shortages of labor in many areas, many cotton warehousemen have found it imperative to use various labor-saving devices.

In nearly all of the larger warehouses, and in many of the smaller ones, industrial power trucks, improved scales, and other modern equipment have been introduced within the last few years as means of saving labor. In some of the smaller warehouses, however, purely manual methods are still used for performing many different warehousing operations. In these warehouses, the management has usually felt that the volume of cotton handled annually was not sufficient to justify the costs involved in acquiring and owning mechanical equipment. In many cases the necessity for extensive alterations in the warehouse itself, such as a revised warehouse layout or the reinforcement or rebuilding of floors and platforms to support the heavier weight of such equipment, have discouraged warehousemen from purchasing mechanical equipment.

Notwithstanding the introduction of powered materials-handling equipment into many types of cotton warehousing operations, relatively large amounts of labor are still employed for handling in most warehouses. Research studies by the Department of Agriculture of the handling of cotton in many types and sizes of cotton warehouses throughout the Cotton Belt have revealed that many additional savings could be made by the more effective use of labor and equipment in many routine handling operations.

How, then, can cotton warehouse managers or foremen go about the task of <u>improving</u> their materials-handling methods? How can they make more effective use of the materials-handling equipment and labor available? Solutions to this problem involve, for each warehouseman concerned: (1) Recognition of the fact that many of his handling operations, even though largely mechanized, probably are not performed as efficiently as is possible; (2) understanding of the causes of inefficient handling and of the ways to increase efficiency; (3) knowledge of some of the simpler tools and techniques that may be used to analyze existing methods to find how improvements might be made; and (4) desire to apply these tools and techniques to his own handling operations and to make changes in his

methods where the need for them is indicated. The remainder of this report is devoted to a discussion of some of the means by which warehousemen can effect such improvements.

In discussing how warehousemen can find ways to improve specific types of handling operations, there may be occasional instances wherein the only satisfactory way to accomplish a desired improvement would be to use a different type of equipment than that on hand in the warehouse. In such cases, before the improvement could be made the new equipment would have to be acquired by the warehouseman. In most instances, however, the discussions in this report deal with ways to use more effectively the equipment and labor already available or on hand.

Causes of Inefficient Handling

Inefficiencies in cotton warehouse handling operations generally arise from: (1) Failure to use suitable powered handling equipment in place of purely manual labor; (2) failure to make proper and effective use of such equipment when it is employed; and (3) failure to make effective use of the manual labor employed, especially on operations in which a crew of workers is used.

Most manually performed handling operations are performed by crews or teams of workers. When a crew of men work together, whether in the performance of a single handling operation, as the unloading of a railroad car by use of hand trucks, or in the simultaneous performance of several operations through which each bale of cotton passes in succession, as when bales are moved by hand truck in an unbroken flow through unloading, weighing, sampling, and transporting to storage, individual activities must be coordinated and the crew organization must be properly balanced, if the best results are to be obtained. Lack of proper coordination and balance in such situations inevitably results in wasted, idle labor at some one or more points in the operation or in the cycle of operations. Research has shown that for most warehouses an efficient method for receiving bales is to use a clamp truck instead of hand trucks for unloading and for transporting to storage, and to make as full use as possible of temporary blocks to separate the different operations from each other. Research findings indicate that when temporary blocks are employed between all operations in the receiving cycle, and a clamp truck is used in place of hand trucks for unloading and for transporting, total labor requirements for receiving often may be reduced by 60 percent or more from those of a sequence of hand-truck operations of the type just noted. In fact, the findings also indicate that even when hand trucks are retained for unloading and transporting to storage--that is, even when a machine is not used at all in the receiving cycle--the use of temporary blocks in

some situations may in itself reduce the man-hour requirements for the job by 20 to 40 percent. 2/

Generally, one of the chief faults of the crew arrangement in purely manual methods is that more workers are used than would be necessary to maintain the rate of production obtained or desired, or to operate at greatest efficiency. This defect is especially prevalent in the larger warehouses, but it is also found in many smaller warehouses. The use of excessive amounts of labor on handling operations is probably a carry-over from an earlier period. In those days if more workers were used on an operation than were necessary, the extra cost was not large enough to become a real problem to the warehouseman. Moreover, most warehousemen did not ordinarily find it necessary to study closely the details of their handling operations, and they were not likely to know whether or not they were using too few or too many men. When a warehouseman was dissatisfied with the production rate of a certain operation, he might seek to increase it by adding a few more workers to the crew. Frequently this did result in increasing the rate to the desired level. This may have led the warehouseman to believe that he had found the proper crew size. However, as is true today, the increase in output was not necessarily in proportion to the number of workers added. In many instances, by the addition of workers the operation became less efficient—and more costly.

After becoming accustomed to oversize crews, which in many instances have come to be regarded as normal and proper in size, many warehousemen find it difficult to realize that in many of their handling operations much labor is being wasted. Even after an analysis has shown that an excess number of workers is being employed on certain operations, warehousemen may not know exactly what to do about it. Often they make the mistake of concluding that, in spite of the idle time demonstrated to be inherent in a certain crew size, it is necessary to maintain that crew size if the desired production level is to be held. Some of the

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2/ A temporary or floating block consists of a number of bales grouped temporarily in one place between the completion of one operation and the beginning of the next. One of its chief purposes is to prevent a "slow" operation in a cycle from lowering to its own level the handling rate of potentially faster operations to which bales are passed or from which they are received. The temporary block accomplishes this purpose by serving as a depository for bales as an operation is completed and a source of supply for the operation which follows, thus permitting the two operations to be performed independently of each other. The effect of the temporary block, when so used, is to remove one of the factors often responsible for lack of balance between operations. For a discussion of the uses of temporary blocks in connection with receiving bales of cotton, see "Some Improved Methods for Receiving Bales of Cotton in Compresses and Warehouses." By Jo Brice Wilmeth and Charles D. Bolt. Agr. Inf. Bul. No. 80. U. S. Dept. Agr. Prod. Mktg. Admin.

ways of determining whether a given crew size is too large, or unbalanced in its organization, and possible corrective measures are pointed out in this publication.

Failure to use powered equipment and failure to make proper use of such equipment also are covered in the examples discussed.

How Increased Efficiency is Usually Obtained

Increased efficiency in cotton bale handling operations usually results from the use of one or more of the following techniques:

1. Separation of interdependent operations (for example, operations linked together by the continuous flow of bales in succession from one operation to the next) so that each operation becomes independent of the others and can be performed separately.

2. Change of method which may involve changes in the sequence of movements or of operations, changes in equipment, in techniques, or changes of other types.

3. More effective use of equipment, which may involve a change in equipment, or increased application of equipment already in use.

4. More effective use of labor, which may involve a change in crew size, a balancing or reassignment of individual duties, or increasing the productivity of labor by applying powered equipment to an operation in which it is not now used.

A cotton warehouseman who wishes to increase the efficiency of his handling operations has several sources of assistance open to him. These vary in effectiveness and in cost and his choice will usually depend on the importance and the urgency of his needs, and how much he is willing to pay for such assistance. The five most common ways in which warehousemen may obtain assistance in connection with their materials-handling problems are:

1. If a warehouseman's scale of operations, or volume of business, is sufficiently large, he may feel justified in keeping one or more full-time specialists on his payroll. Where possible, such persons should be industrial or mechanical engineers, with training in materials handling, time and motion study, and methods analysis.

2. Some warehousemen who do not feel they can justify the employment of a full-time specialist may feel they can make good use of a properly trained person who spends part of his time on materials-handling problems and the remainder on other duties.

3. A professional consulting engineer may be employed on occasion and for short periods for assistance in solving particular materials-handling problems.

4. Assistance may be obtained from manufacturers of materials-handling equipment. Many firms provide consulting services without cost to prospective purchasers of their equipment.

5. A warehouseman may, through careful observation and the application of common-sense principles, undertake the analysis of his own handling operations and devise improvements in them. It is primarily for these warehousemen that this publication has been prepared.

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BASIC TOOLS FOR ANALYZING AND MAKING IMPROVEMENTS IN COTTON-HANDLING METHODS

Every cotton warehouse manager, superintendent, or labor foreman is or should be interested in finding better methods for perfoming the various handling operations under his supervision. He knows that better methods will reduce delays, make work easier for his men, and increase the rate of handling.

Methods engineers point out that, although there are many ways to do a job, there is only one best way. To find the best way for performing an operation is the object of methods analysis. Whatever way is found to be best is, of course, best only with respect to a given time, place, and state of the arts. As technological advances are made, including designs for new equipment, and as new or different points of view are brought to bear on a problem, still better methods may result. A basic principle in methods improvement work is that methods used should be reviewed at regular intervals, even after improved methods have been put into effect, to make sure that still newer and better methods are not being overlooked. In the development of improved methods, eternal vigilance is the price of progress.

Before Undertaking an Improvement Learn How the Operation is Actually being Performed

It has been said that there are three ways in which a job or operation may be performed: (1) The way it is actually performed; (2) the way people think it is performed; and (3) the way it is supposed to be performed. Very often it has been found that a cotton warehouse manager thought an operation under his supervision was being performed in a certain way when in reality it was being performed in a different way. A warehouse manager is not always aware of certain features of some of his operations because he has not closely examined the handling methods used, or he has not realized the importance of certain features.

The first step in methods improvement, then, is to learn what is actually done in an operation, which almost always means that the facts concerning the way an operation is conducted must be obtained by direct observation. When these facts have been learned, steps may be taken to devise the way the operation is supposed to be, or should be, done to achieve greater efficiency.

To develop better handling methods from observation of existing methods or operations, a systematic way of making observations is needed. This systematic approach is what is generally meant by the term "methods improvement." Some other terms used to mean much the same thing, are "work simplification," "methods analysis," "operations improvement," and "motion study."

Process Analysis Charts

The professional methods engineer, in studying an operation for which he seeks an improved method, will very likely use one or more different types of technical tools or aids in making his analysis of the operation. Among these are flow diagrams and flow process charts. Some of the aids of this type which are applicable to materials-handling operations are: (1) Product analysis charts—wherein a product, as a bale of cotton, is graphically followed through the successive stages of an operation; (2) man analysis charts—wherein a person, as a hand trucker, is followed through each step of the operation; and (3) multi-man analysis charts—wherein the work of a crew of men, as an unloading crew, is followed.

To make profitable use of aids of this sort, some familiarity with the methods of constructing and interpreting such charts is necessary. However, the time required to develop this familiarity very likely will be more than most cotton warehousemen are willing or able to spend for this purpose. When properly used, however, these or similar analysis charts may frequently prove helpful in developing improved methods for certain types of handling operations. Such charts help one quickly to visualize the significant relationships within an operation or among several related operations, and thus make it easier to detect inefficiencies. (More about these aids may be learned by consulting "Suggested References," listed in the Appendix.)

Time Study in Methods Improvement

Time study is another specialized tool used by engineers and others who specialize in methods improvement. It is rather generally agreed that supervisory people who are interested in developing better ways of doing the jobs for which they are responsible would find a familiarity with the fundamentals of time study helpful. The degree of familiarity that would be necessary for best results in devising improved methods would no doubt vary according to the responsibilities and duties of the individual foreman and according to the nature of the work he supervises. In some industries, such as manufacturing and processing, and particularly on machine operations, time study is widely used for such purposes as determining the time standards for performing certain operations and tasks, as an aid in setting production schedules, and as a basis for setting piece rates or incentive wages. For these reasons it may be worth while to foremen or supervisors of certain types of operations to acquire a detailed knowledge of time study. One leader in the field believes "that every foreman (who supervises machine operations) should be given at least 2 years of intensive training in time study." 3/

3/ "Time Study Fundamentals for Foremen." By Phil Carroll, Jr. McGraw-Hill Book Company, Inc. New York.

Although it is doubtful whether formal training in time study is necessary for foremen or others who supervise labor in cotton warehouses, it is undoubtedly true that many supervisors would find knowledge of a few time study fundamentals helpful in their work. (Those interested in learning more about time-study analysis than may be obtained from the brief discussion in this section are referred to "Fundamentals of Time Study" and "Suggested References," in the Appendix. The list of references shown is representative but is by no means exclusive.)

How Time-Study Data may be Used in Comparing Different Methods

By means of time studies, it is possible to determine the elapsed time (in hours or minutes) required for handling a given number of bales of cotton in a specific operation, for each of two or more different methods, when the effects of interruptions and delays, not related to the method, and differences in the level of performance of different crews have been eliminated. When the adjusted elapsed time required for performing an operation by use of a particular method is multiplied by the number of men in the crew, the number of man-hours or man-minutes of labor required to perform the operation is obtained. Labor requirements determined in this way for each of the various methods provide a measure of the relative labor efficiency of each method.

Comparison of Methods Often Possible without Refined Time Study Analysis

As a practical matter, a cotton warehouseman interested in comparing one handling method with another may not be in a position to have time studies made which would provide him with detailed time information on each method. Moreover, for his purposes, he may have no need for so much detail. If his only problem in comparing two methods is to choose the one that would save the greatest amount of labor, there are a number of ways wherein it is possible to make comparisons on the basis of only a few roughly determined facts.

An example of how comparisons were made and equipment was selected, without time studies being made in all cases, is the replacement in many warehouses of the manual car-loading method by the clamp-type industrial lift truck method. The old methods in which the car floor was filled out by hand trucks, and the tiering or topping was performed manually, either with or without the assistance of a portable elevator, escalator, or other lifting device, required relatively large amounts of labor. Depending on the distance the bales had to be hauled to the car, the type and number of bales to be loaded, and the rate of loading desired, from about 5 to 15 loaders and hand truckers were often used to load a single boxcar. The manual-hand-truck loading of 100 bales was seldom completed in less than an hour and often required up to twice that.

When it was demonstrated that one operator and a clamp truck often could perform the same operation in from 30 to 45 minutes, this was evidence enough, without any refinement of the analysis, to indicate the comparatively greater efficiency and lower cost of the clamp-truck method. Consideration of delay time was unnecessary since it was obvious that whatever delay time was inherent in the manual-hand-truck system of loading could be entirely eliminated by completely changing the method of loading, so that the entire loading operation could be accomplished by means of a single machine and operator.

Moreover, it was unnecessary to take into account differences in worker performance, since it was apparent to the experienced warehouseman that a manual-hand-truck loading operation could not be performed at a rate or in such a way as to excel the efficiency of the machine method. Nor were elemental times needed for purposes of comparison. Over-all elapsed time (for handling a given number of bales, of course) was all that was required.

The point emphasized is that no greater supply of detailed facts is necessary for making comparisons than is required to reach an accurate conclusion. A refinement of the data in the example shown would not have led to a different conclusion--that is, a different choice of method. Moreover, it was obvious, almost from the beginning, to any experienced warehouseman that more detailed information was not needed, since it was apparent <u>how wide</u> were differences in manpower required under the two methods. For example, if it required 10 workers 1½ hours (or 15 man-hours) to load 100 bales into a car manually, and 1 worker 1 hour (or 1 man-hour) to load them by clamp truck, the labor savings resulting from the use of the truck would represent 14 man-hours for every car loaded. If, for ease in calculation, it is assumed that all workers--including the clamp truck operator--are paid $1 an hour, and that the cost of owning and operating the clamp truck also is $1 an hour (a reasonable assumption for many situations), the net dollar savings in loading a car would be $13. At this rate, enough money would be saved in the loading of 300 cars to cover the purchase of a clamp truck costing $3900.

When the differences between any two methods, measured in this broad way, are not large enough to assure confidence that there is a <u>real</u> difference in efficiency or cost, steps may need to be taken, through time study or other means, to obtain more detailed knowledge of the effects of each of the methods.

How the Timing of an Element Can Assist in Improving a Cotton-Handling Operation

Although certain comparisons can be made by use of over-all elapsed times or over-all labor requirements, the timing of the <u>elements</u> of an operation cycle is usually required to detect ways in which a method may

be improved. When the times of all elements in a cycle are obtained, they usually afford a basis for developing any possible improvements. When the time for only one of several elements of an operation is obtained, it may be necessary to relate this information to the over-all elapsed time for a complete cycle or a complete operation before its significance can be understood. A simple example can be shown by the warehouseman who times a weighing operation, in which a platform scale and hand trucks are used, and finds that cotton is being weighed at an average rate of 120 bales per hour, or two bales per minute, and that the average time required to weigh one bale is 30 seconds. This information alone is not likely to suggest whether the present weighing rate is all that might be expected, nor to indicate any particular way in which improvements might be made. However, the warehouseman who times the elements of the weighing cycle to obtain the over-all time may also have enough data to provide the basis for improving the method. Since he is not a time study expert, and perhaps does not wish to get into any complicated timing and recording procedures, the warehouseman may decide to time just one element to find out, for example, how much time is required for a bale to enter and leave the scale platform. For this purpose he may decide to begin the timing of the element when the wheels of the hand truck carrying the bale touch the edge of the scale platform and end the timing just as the wheels leave the platform. These, then, are the "break points" which, respectively, separate in time this particular element from the elements which immediately precede and immediately follow this element. The elapsed time between these two break points includes, but does not necessarily coincide with, the time required for actually weighing the bale. However, it may be convenient to assume that this time represents the time for weighing a single bale, and it would therefore represent the time the scale crew may be regarded as actually occupied with their duties.

If this "weighing" element is timed during a number of cycles of weighing and it is found that on the average 15 seconds are required in getting a bale on and off the scale, the warehouseman--by working forward from this figure and taking into account the information previously revealed by over-all timing--may conclude that if bales could be placed on the scale fast enough to keep up with the ability of the scale crew to handle them, twice as many bales--or 240 rather than 120--could be weighed per hour. Under the conditions assumed here, it might not be possible in actual practice to attain the maximum potential weighing rate suggested by timing of the weighing element, since interferences caused by hand truckers entering and leaving the scale, and other factors, need to be considered. However, this information indicates that there may be room for improving the weighing operation. It also suggests that the place to look for possibilities for making improvements is in factors that prevent more bales from crossing the scale.

Possible sources of trouble of this kind are:

1. Delays in, or slow production rates of, a preceding operation, as where the unloading of a railroad car or motortruck is carried on simultaneously with the weighing, and each bale is hand-trucked directly to the scale after it is unloaded.

2. Too few hand truckers for distance traveled in the weighing operation or in the complete cycle of operations of which it is a part. If in a receiving operation, for example, the scale, car break-out, sampling, and other crews consistently wait for hand truckers to arrive, it is apparent that too few hand truckers are being used for most efficient work from these crews. (If hand truckers are usually waiting in line at the scale, car, and sampling station, there are probably too many rather than too few hand truckers, and the reason for the delay in weighing will probably be found in some other factor.)

3. Hand truckers working at a pace below normal. (There is also the possibility that during the weighing operations that were timed the scale crew was working at a pace considerably above normal. If the warehouseman suspects that either hand truckers or scale crew were not performing at a reasonably normal level, he should continue observation of the weighing operation until he has assured himself as to the facts.)

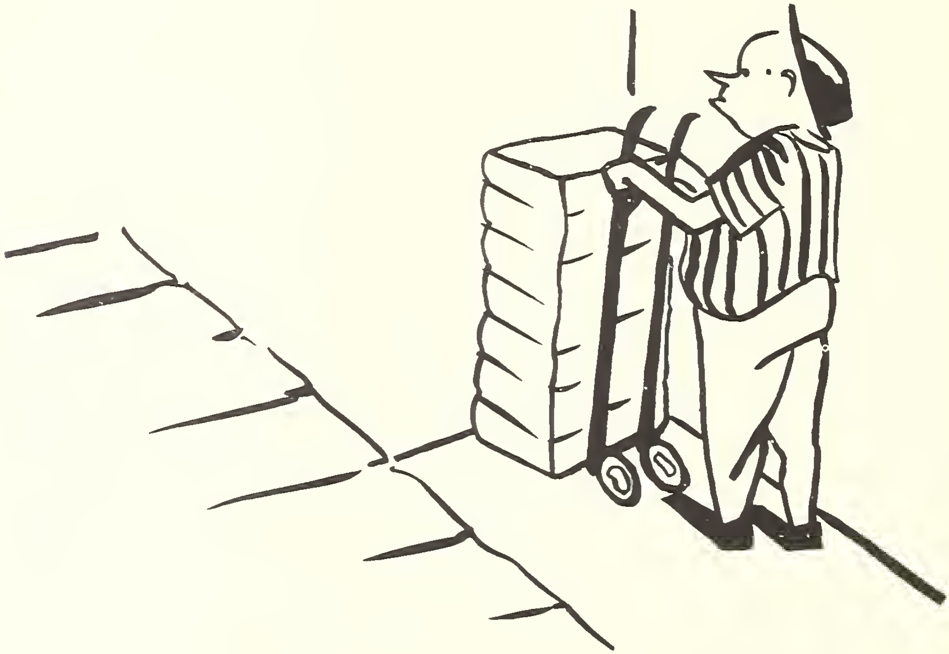
If by timing the weighing element in this operation it is found that the scale crew is actually working about half the time, it of course follows that the crew is idle about half the time. This fact could have been discovered just as well by timing directly the <u>delay time</u> (idle or wait time) in the operation. Although there are many instances in which it is important to know the time required to perform one or more elements of an operation, usually, when only part of an operation is to be timed, the phase most likely to result in a basis for improving the operation, and therefore the one that should be studied most closely, is delay time. When delay time is high in proportion to work time, it can be regarded as an indication of trouble somewhere within the method used.

Delay Appraisal without Timing

There are instances in which it is possible to estimate the amount of delay or wait time resulting from a particular method simply by observing how various elements or phases of the operation are associated with periods of waiting by different members of the crew. Such estimates may be made without the use of a watch.

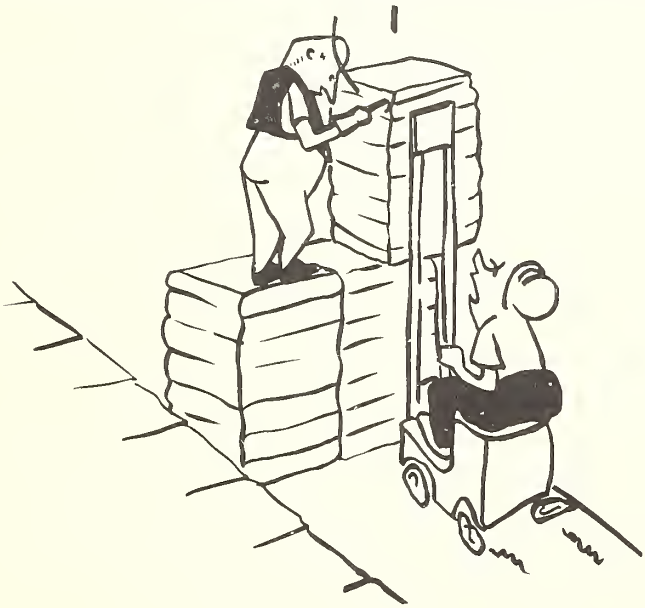
To illustrate, a storing operation observed in a small warehouse is described as follows: A crew of three men was used to store flat bales in two rows along part of the warehouse wall. The row next to the wall (the first row) was "topped" so that bales in this row were arranged two-high on head. The second row was only one-bale high on head. Bales to be stored were brought down a relatively narrow aisle, hemmed in by other rows of bales, from a temporary block about 30 feet away from the stacking area. Bales were transported to and placed in the stack by both a hand truck and a fork-lift truck.

In beginning the stack one worker, by use of a hand truck, first placed a bale on head next to the wall where a row was to be formed.



He then returned to the block for another load, brought the bale to the stack, and beside the bale placed first, he then placed the second bale in the second row.

Having thus deposited two bales, one in each row, the hand trucker cleared himself from the aisle, and a second worker, operating a fork truck, brought from the block to the stacking point a third bale. Assisted by a "topper" (the third man in the crew, who worked from the top of the adjoining bale in the second row), the fork truck positioned the third bale on top of the bale previously placed in the first row.



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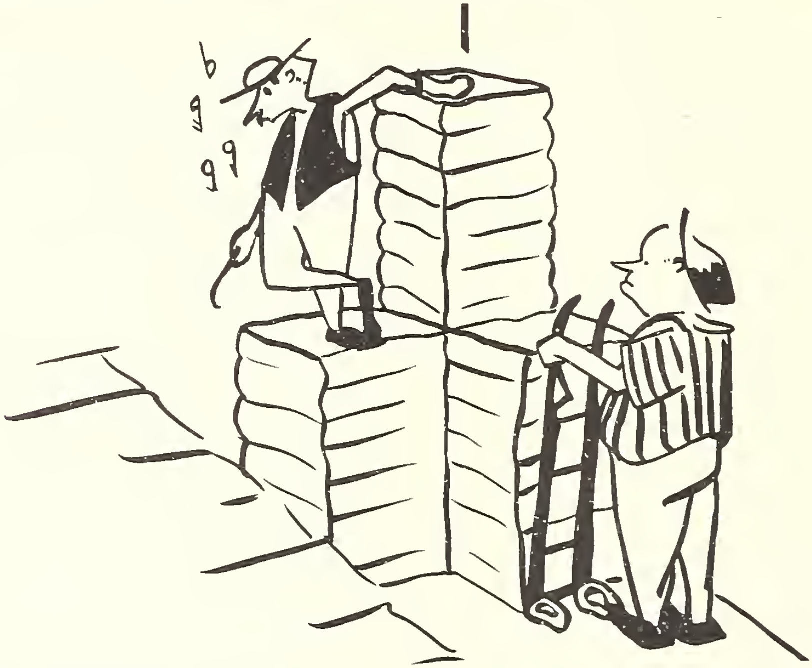
The topper had two duties, to tip the bale slightly and hold it fast while the truck driver, in backing away, pulled the forks from under it, and then, where necessary, manually to maneuver the bale into its proper position in the stack. When the fork truck had backed out of the aisle, again clearing a passageway to the stack, the hand trucker approached the stack with a fourth bale and placed it on head in the first row as he had done with the first bale.



The fifth and sixth bales were then placed in a similar manner to that indicated for the second and third bales. This cycle was repeated until the formation of the two rows had been completed.

By observation it was possible to estimate roughly how much delay or wait time was involved in this method of storing. The following general conclusions were reached:

1. The hand trucker was idle almost one-third of the time, since he placed only two out of every three bales positioned in the stack, and could not work at the stack while the fork truck was engaged in raising and positioning each third bale.

2. The fork truck and operator were idle about two-thirds of the time, since the fork truck placed only one bale out of every three placed in the stack and could not work while the hand trucker was positioning the other two bales.

3. The helper working on top of the stack was idle more than two-thirds of the time since he, too, worked on only one bale out of every three (that is, only when a bale was "topped" by the fork truck), and his duties in this connection required less than the full time necessary to handle each third bale.

This amount of idle time was more than sufficient to indicate that the method used was inefficient. Several solutions suggest themselves. One solution would be to replace the fork attachment on the industrial lift truck with clamps so that the machine alone could position <u>all</u> bales—lower as well as upper—in both rows, without any hand truckers or other workers being required. (Under more favorable conditions, where there is room enough for the clamp truck to maneuver freely, these bales could in fact be placed both on the floor and in the upper tier two at a time.) Another possible solution might lie in reducing the length of the forks which would make it possible for the fork truck alone to accomplish the same job, but at a slower rate and in a less efficient manner, than when clamps are used. It is frequently difficult to release bales from the forks of a lift truck—thus requiring the use of a helper—when the forks are too long to allow a sufficient area of the bagging to drag as the bale is set down, and there is not enough friction to pull the bale off the forks. In the case observed, the length of the forks appeared to be the reason for the trouble. Reducing their length would have been the least expensive way to make possible the elimination or reduction of wait time (by changing the <u>method</u> of stacking) and otherwise to improve the efficiency of the operation. However, for the long run, especially if considerable stacking is done, greater savings would be realized by using a clamp truck, since it is more efficient than the fork truck both in transporting and in stacking bales.

TECHNIQUES FOR FINDING WAYS TO IMPROVE COTTON-HANDLING METHODS

What is usually desired of any handling operation is to get the job done--whether unloading motortrucks, sampling bales, or transporting bales to the storage area--in the shortest time, with the least effort, and at the lowest over-all cost.

Warehousemen sometimes place greater emphasis on one of these goals than on the others. When it is considered necessary to complete an operation in the shortest possible time, additional effort, manpower, and equipment may be required. Frequently, though not always, this may result in reducing the efficiency and increasing the cost of performing the operation. Where this occurs, such an increase in cost represents the cost of greater speed. 4/ Conversely, to perform the operation at the lowest possible cost, it may be necessary also to allow more time for, and to use less labor in, its completion.

In many instances, however, the cotton-handling method found to be faster also will be found to be cheaper, since increased speed is usually obtained by eliminating or reducing delay time, by substituting mechanical equipment for manual labor, or by making more effective use of equipment and labor already employed. Reduction of wait time, replacement of manual labor by machines, and the more effective use of equipment and labor usually result in reduced costs.

Questioning Attitude Necessary

If a warehouse manager or foreman is to succeed in finding those methods that result in the greatest savings of time, labor, and money, in his cotton-handling operations, he should assume a questioning attitude toward every aspect of every operation. A healthy frame of mind for this purpose is always to be dissatisfied with things as they are.

The fact that a certain operation has been done the same way for years should not be taken as proof that the best method has already been found. Such a method should be examined as carefully and with as much attention to detail as any new method undergoing a trial.

4/ The speed of operation, in the sense of total number of bales handled, generally is increased more efficiently by using two or more optimum-size crews rather than a single enlarged crew. For example, if the most efficient or optimum-size crew for a particular type of operation is 3 men, a greater increase in the volume of bales handled in a specified time is obtained by adding one or more 3-man crews, which work independently, than by adding the same number of workers to the original crew.

A questioning attitude should be adopted so that nothing about an operation or a method will be taken for granted, or will be accepted as good simply because it has always been done that way. The time and place of the handling operation, the way it is being performed, and the type of equipment used should be subjected to careful scrutiny to determine whether, and in what ways, improvements might be introduced.

Reluctance to make changes is characteristic of many people. Such reluctance is found as often among warehousemen as among other groups. Yet, the habit of accepting old practices as desirable or good merely because they are old and well established is a sort of mental trap that tends to prevent the development of new ideas or better methods. A cotton warehouseman seriously interested in improving his handling methods should not permit himself to become so satisfied with his warehouse operations that he tends to resist ideas that might change these operations. Such an attitude frequently prevents the adoption of improved methods of great value.

There are at least two other mental traps that a cotton warehouseman should avoid. One is the tendency to reject a new idea or a proposed method on the ground that "it might work in another warehouse but it won't work in mine; conditions here are different." Since every cotton warehouse is different in some respects from other cotton warehouses, this trap is an easy one to fall into. The differences, however, may in no way apply to the suitability of the proposed method. The third mental pitfall is the tendency to reject a proposed method because "we tried that once and it didn't work." Frequently, the warehouseman is mistaken in his impression that the method has been tried. A method including some of the same features of the proposed method may have been tried without success, and the warehouseman, recognizing that these features are familiar to him, may jump to the conclusion, before he stops to examine the new method carefully, that it is the identical method that was tried and "didn't work." However, even if the method had been tried--and failed--this does not necessarily prove that it should not be tried again. The conditions under which it was first tried should be compared with conditions existing at the present time to find out whether changes have taken place that might make the proposed method workable. Equipment used in the proposed method should be examined to find out whether changes have made it more suitable. All factors affecting the use of the proposed method should be studied. It is significant that the warehouse reported to have originated the clamp attachment, now used so widely on industrial lift trucks, once rejected this attachment because "it didn't work." Later examination of the clamp led to a change in a mechanical feature of the attachment which took care of the difficulty which had led to its rejection.

It should be emphasized that a questioning attitude assumes an open mind. If one is not prepared to accept new ideas to which the questioning of a method or operation might lead, it is obvious that there is little point to the questioning.

Selecting an Operation for Study with a View toward Developing an Improved Method

Ordinarily, it is impractical for a warehouseman to study simultaneously all handling operations. Usually it is desirable to complete the analysis of one type of operation before proceeding to another. Therefore, careful selection of the first operations for which improvements are sought is important.

In surveying his operations the warehouseman should look for those causing bottlenecks, or that take too much time, or that involve too much waiting on the part of some of the workers. He should look first for operations that are relatively costly and that present opportunities for large savings. It is on these operations that his efforts have a chance of bringing the greatest returns. However, opportunities to achieve small savings should not be passed by, but these opportunities should be postponed for later study; the more important operations should be considered first.

Questions Pertinent to the Study of an Operation

As previously pointed out, some warehousemen are not as familiar as they might be with certain details of handling operations under their supervision because they frequently have had no occasion to use such detailed information and, as a consequence, have not considered it important to obtain such information. However, the first step in devising an improvement in a method is to understand accurately the nature of the present method, which may mean first getting rid of the notion that the method is already understood. Careful observation of the method for a short period should indicate to the warehouseman whether he really understands its workings as well as he supposes he does.

Through long experience, methods-improvement workers have found that when a series of questions are raised and answered about every detail of an operation being studied, ideas for a better method are often suggested. The questions that should be asked in regard to each element or segment of the work are:

1. WHAT is done?	(What is its purpose?)
2. WHY is it done?	(Is it necessary?)
3. WHO does it?	(Could someone else do it better or at less cost?)
4. WHERE is it done?	(Would another place be better?)
5. WHEN is it done?	(Would another time be better?)
6. HOW is it done?	(Could it be done another way at less cost?)

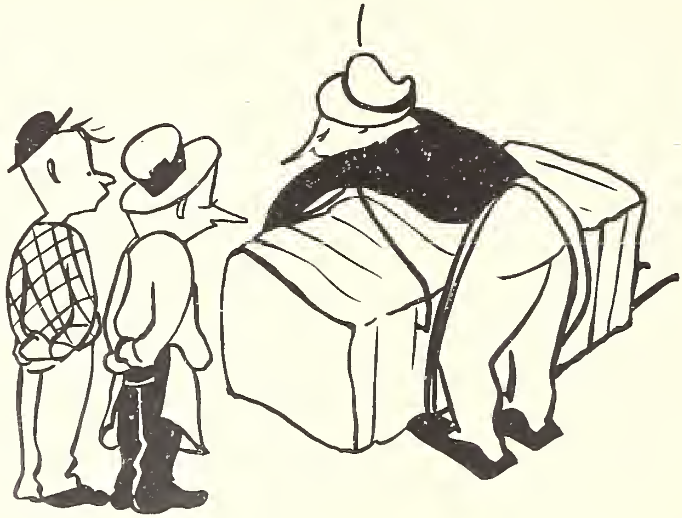
In some situations the warehouseman may be inclined to feel that the answers to certain questions and the necessity for certain procedures and practices are obvious enough, and that no further explanation or justification is required. In adopting such an attitude, however, the warehouseman runs the risk that some activity or operation that ought to be discarded will be allowed to continue. To assume that there is no need to ask a certain question may easily lead to the conclusion, without examination of all the facts, that any change is either unnecessary, undesirable, or perhaps impractical, when in fact this may not be the case. Examples of how these questions, when applied to the past, have led to cotton-handling improvements follow:

1. "WHAT is done?" This question was applied to an operation of resampling at one warehouse, where during one season a very large proportion of bales had to be resampled after being placed in storage. It resulted in a decision to take two samples rather than one when a bale was first received. When the asking of this question caused the warehouseman seriously to consider the problem, he realized that the over-all cost of sampling all bales twice on receipt was less than the over-all costs involved when a large proportion of bales were later broken out of storage and resampled. (It should not be assumed that this would necessarily hold true in other warehouses or under other conditions; circumstances may indicate an entirely different procedure would be desirable.)

2. "WHY is it necessary to use hand truckers in a weighing operation?" This question once generated a train of thought that led to the development of the mobile beam scale, which eliminates the need for hand truckers in the weighing of flat bales. (The mobile beam scale is a cotton beam scale mounted on wheels. The scale crew rolls the scale over a row of bales lined up for weighing. Thus, it is not necessary to hand truck each bale to the scale.)

3. "WHO does the job and who could do it better or at less cost?" One warehouseman raised this question in regard to an operation employing two workers--and found a simple way to save the labor of one worker. In the original operation two men worked on opposite sides of a trailer or of a hand truck--on which bales were brought to them for stacking--to insert hooks in a bale so that it could be removed by a boom truck and stacked. Each worker inserted hooks into the end or side of the bale nearest him. A critical examination of this procedure, in seeking an answer to the question raised, led the warehouseman to replace the two men with one exceptionally tall man who, while using one hand to insert hooks into the end or side nearest him, was able to reach far enough over the bale with his other hand to insert

hooks into the opposite end or side also. Thus, the labor of one worker was saved because it was found that in this operation a properly selected worker could do the work of two.



4. "WHERE is the work done and could it be done better at another place?" This question, when applied to the sampling of flat bales of cotton, led to the substitution of block sampling for the sampling of bales on hand trucks immediately following the weighing operation. This change in method eliminated most idle time inherent in a method in which bales are sampled on hand trucks while passing from one operation to another, and thus made it possible to increase the rate of sampling flat bales and also to reduce the cost. 5/

5. "WHEN is it done and could it be done better at another time?" This question, when applied to the order in which compressed bales were placed in a cordwood stack by a boom-type stacking machine, led to a change in the order of placement which resulted in a reduction of 25 percent in labor costs for stacking. 6/

5/ Block sampling is the sampling of bales while they remain in a temporary or permanent block. Usually, but not necessarily, the sampling block is a row of bales. Block sampling is described in "Some Improved Methods for Receiving Bales of Cotton at Compresses and Warehouses." By Jo Brice Wilmeth and Charles D. Bolt. Agr. Info. Bul. No. 80. U. S. Dept. Agr. Prod. Mktg. Admin. March 1952.

6/ The improved method under which the building of a cordwood stack was separated into two stages so that it could be done more efficiently, and by a smaller crew, is described in a report entitled "An Improved Method of Stacking Standard Density Bales in 'Cordwood' Arrangement." By Alan W. Steinberg and Charles D. Bolt. U. S. Dept. Agr. Prod. Mktg. Admin. May 1950.

6. "HOW is it done, and could it be done more cheaply?" This question has led to the substitution of powered handling equipment for manual labor in many cotton-handling operations. At one time, some of these operations were regarded as unsuited to machine methods. In a great many cases the substitution of powered equipment for labor has resulted in substantial savings.

These questions have been discussed to develop understanding of what is actually being done, to test the necessity of performing each phase of an operation by the method in use, and to suggest ways in which certain improvements might be made. After they have been carefully considered, the following supplementary questions, which provide further aid in planning an improved method, should be asked with respect to every operation:

1. Can the operation, or any part of it, be eliminated?
2. Can the operation, or any part of it, be combined to advantage with some other operation?
3. If the operation, or any part of it, is combined with another operation, can it be separated to advantage?
4. Can a better sequence of operations be used?
5. Can the operation be simplified?

Sometimes the answer to a certain question in the first series may suggest an improvement along lines indicated by one or more of the questions in the second series, but this does not mean that such questions are necessarily duplications of one another. The two sets of questions emphasize somewhat different ways of looking at a problem.

Examples of how questions of the above-indicated types can lead to cotton-handling improvements are as follows:

1. "Can the operation be eliminated?" This question centers around the WHAT and WHY questions mentioned previously. Obviously, the first decision that should be made about any operation, or any part of it, is whether or not it should be done at all. There is no point in wasting time to improve an operation or activity that can be eliminated entirely. (The "elimination" of an operation sometimes means only that a different method is substituted to accomplish the same result; however, the raising of the question is often necessary to draw attention to the fact that substitution of a new method is possible.)

How a particular kind of hand-truck transporting operation was eliminated is shown in the following example.

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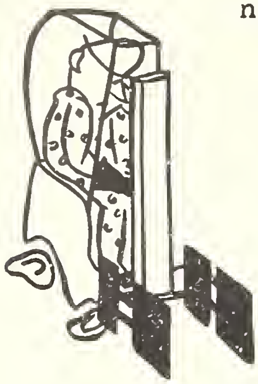
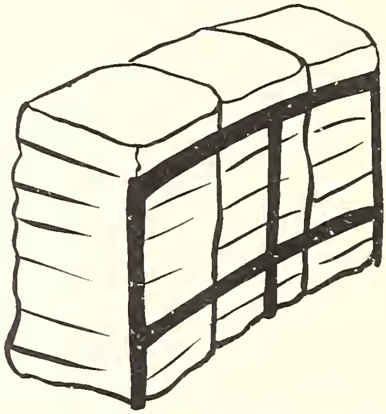
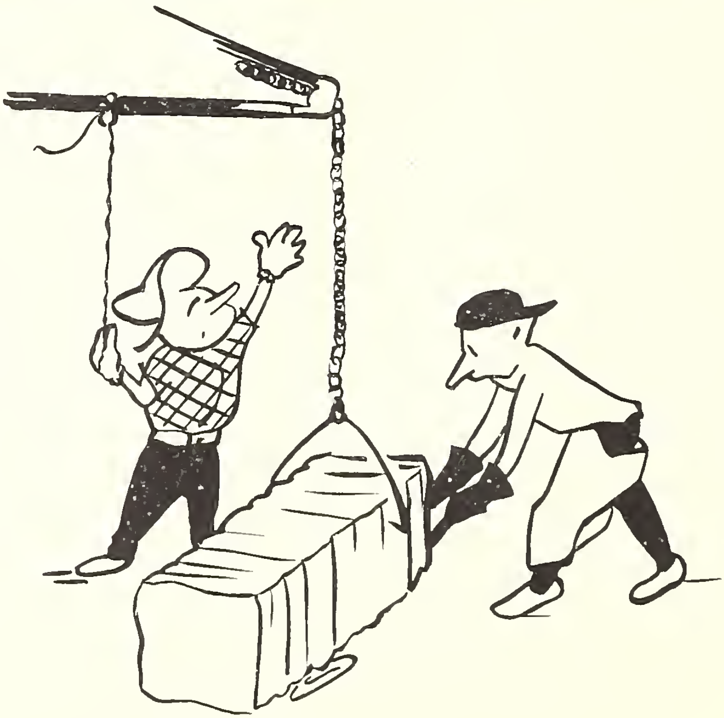


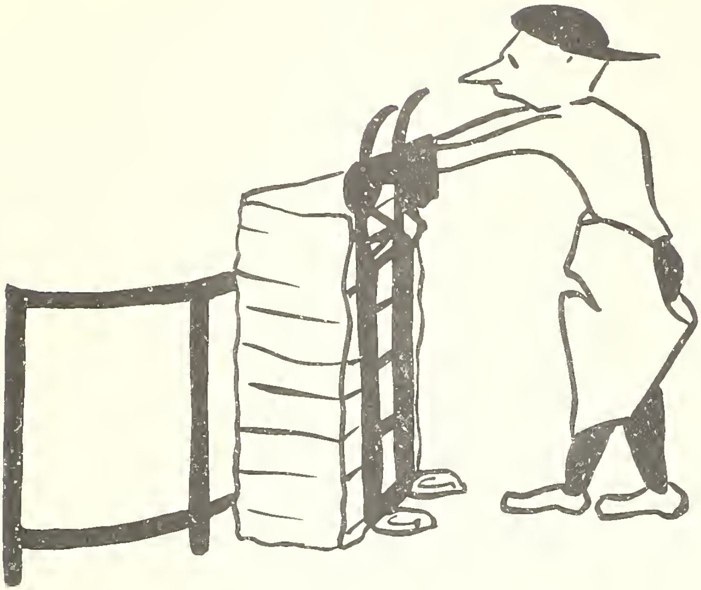
Most compresses which "load out" compressed cotton directly from the press use either a "dead man's post" or a "buck bar" near the press as a prop against which newly pressed bales can be set while they are waiting to be picked up by a clamp truck for loading into a railroad car.



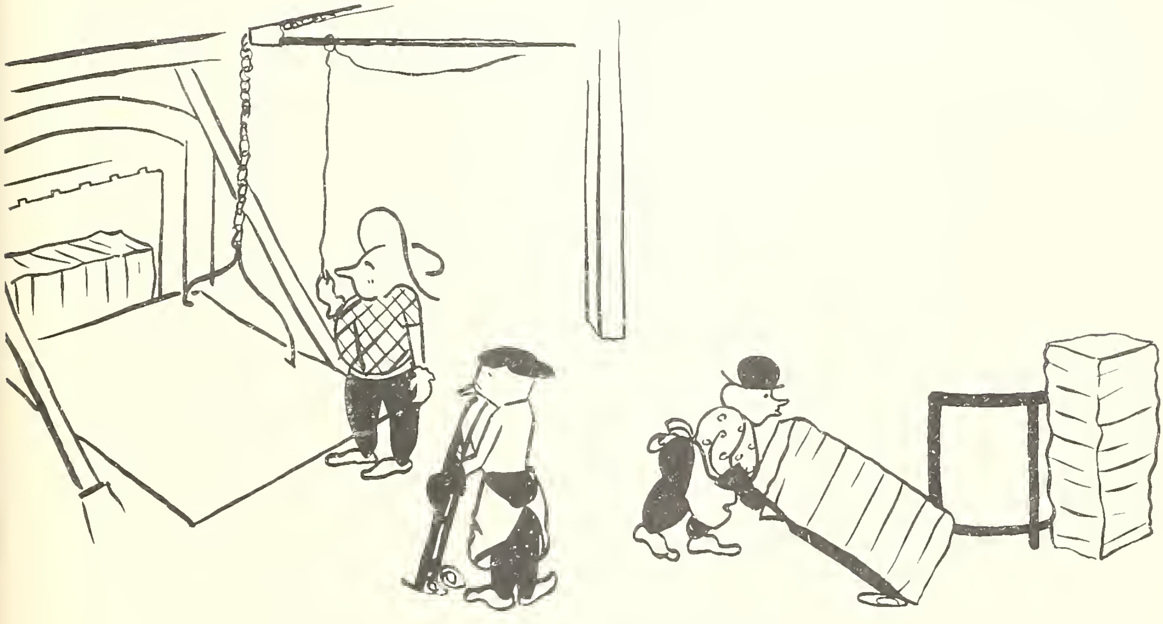
In many plants, bales are brought to the buck bar by hand trucks. In these plants, as each bale leaves the press, a worker (known as the header) lifts the bale by means of a jib crane (often called a "swivel hoist" or "steam hoist"), and places it on a hand truck.



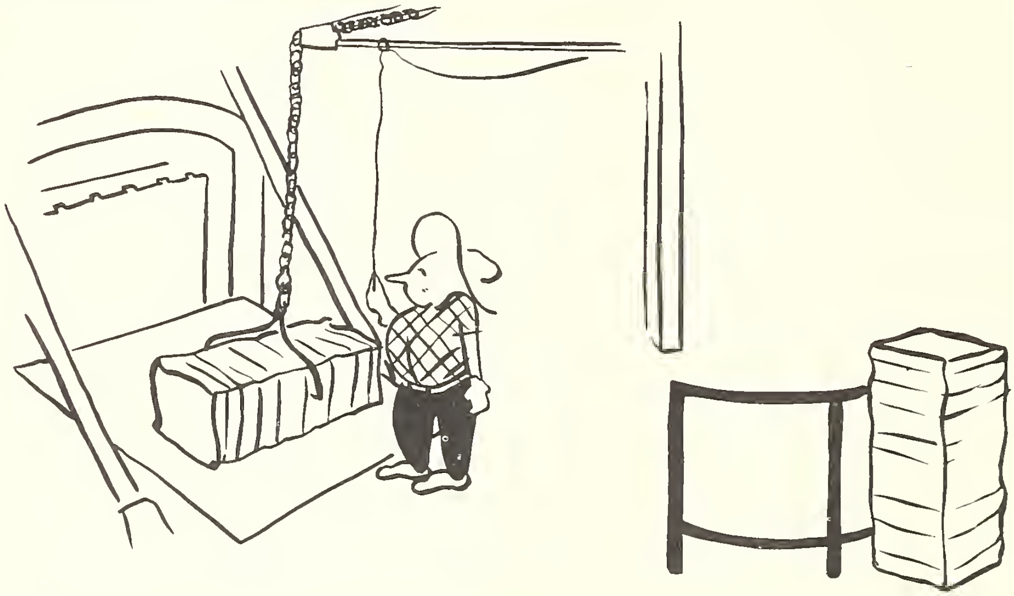
The hand trucker then pushes the bale to the buck bar and dumps the bale on head against the bar.



Two hand truckers are usually used for transporting the bales to the buck bar.



A simpler system, which eliminates the hand-trucking of bales to the buck bar, is now being used by a number of compresses. The elimination of the hand-trucking operation is made possible simply by locating the buck bar within the radius of the jib or boom. By swinging the jib from the pick-up point at the press to the buck-bar area, a bale can be placed in position against the buck bar by the header alone.



The two hand truckers are thus released for other work.

2. "Can the operation be combined to advantage with some other operation?" The nature of cotton handling is such that it is frequently advantageous to separate rather than combine operations. However, there are several situations in which certain phases of different operations may be combined so as to result in a considerable increase in efficiency and a lower total cost.

Observations show that in transporting bales within a warehouse there is about as much empty travel by workers and equipment as there is loaded travel, because the transporting equipment generally makes one empty return trip for every loaded trip. In other words, during roughly half of the travel time involved in an operation the carrying capacity of the equipment is, in effect, wasted. This situation occurs regardless of whether the bales are transported by hand truck, clamp truck, tractor-trailer train, or other means. Although some empty travel by hand trucks may at times be desirable to relieve the fatigue of hand truckers, empty travel is unnecessary to relieve fatigue of operators of clamp trucks, tractor-trailer trains, or other powered transporting equipment.

The prevalence of situations in which there is so much empty travel by warehouse transporting equipment generally is owing to the fact that in most warehouses such equipment usually is assigned to one handling job at a time and, where the transporting of bales is involved, bales usually are transported in one general direction only. Therefore the equipment travels

loaded only when going in the direction in which bales are to be carried. When the equipment returns to pick up another load of bales, it returns empty.

In every transporting operation, travel time represents a large part of the total time involved. In many operations it represents most of the time involved. For instance, in transporting bales approximately 300 feet by means of a clamp truck, carrying 2 bales on each trip, more than 90 percent of the total time is required for transporting and less than 10 percent for picking up bales at the point of origin and setting them down at the point of destination. At least 50 round trips are required for every 100 bales carried. Thus, when half of the travel time is spent carrying no bales at all, it is evident that a substantial proportion of the total time and the total expense is involved in waste travel.

Although waste travel is found to some extent in almost every cotton-handling operation that involves transportation, it is obvious that in many instances there is nothing that could--or should--be done about it, because it is impractical to have every individual item of equipment carry a full load of bales every moment it is in use. Also, in many situations the length of the empty haul might be so short that any attempt to reduce it by the means suggested for other situations would be likely to result in increasing rather than decreasing empty travel.

However, where bales are being transported a considerable distance, necessitating equally long return trips by empty transporting equipment, it usually will be desirable to reduce the amount of waste travel as much as possible. Situations where such reductions are possible are common in a number of cotton warehousing operations.

One possibility for reducing the proportion of time involved in empty or waste travel of transporting equipment is to combine or integrate different movements of bales throughout the warehouse so that, wherever possible, equipment used to transport certain groups of bales in one direction as part of one operation can be used on the return trip to transport other bales in the opposite direction as part of another or different operation. Such combinations of transporting operations are best accomplished through advance planning or scheduling of the operations concerned. Where many long hauls are involved, the savings from the reduction of waste travel often will be more than enough to justify the effort required for proper planning. To illustrate how two different transporting operations might be integrated so as to minimize the amount of empty travel involved, a situation common in cotton compresses and warehouses is described.

In most of the larger warehouses, before bales are compressed or shipped they are customarily brought from one or more storage areas in the warehouse to a "segregating room" or compartment where they are assembled into lots preparatory to the loading or pressing operations. The equipment used to bring bales to the segregating room ordinarily travels empty on each return trip to the storage areas, since it is customary for the equipment to be used only on this job until the transfer of bales to the segregating room has been completed. It is not uncommon to find that at the time

bales are being transported to the segregating room other workers and equipment are moving other bales from unloading platforms or receiving compartments near the segregating room to storage in or near the compartments from which bales are being brought to the segregating room. Or, if newly received bales are not being stored while other bales are being segregated, they may remain in temporary blocks along the platform or in a receiving compartment until the equipment needed to transport them to storage areas can be released from other operations. In either case, workers and equipment are not being used as efficiently as possible. In this situation there may be opportunities for combining or integrating the different operations so that the same equipment may be used both to carry bales to the segregating room from the break-out area, and on the return trip to carry other bales from points in or near the segregating room to storage areas.

To make this example more specific, assume a case where there are blocks of newly received bales deposited at various points along an unloading platform, that these blocks of bales lie between a segregating room located in the press compartment and various storage compartments, and that these bales have been unloaded, tagged, weighed, and sampled, and are ready to be moved to storage. Assume also that while these bales are waiting to be moved to storage, other bales are being transported by one or more clamp trucks from a break-out area in a storage compartment to the segregating room. If usual practices are followed, each clamp truck will travel loaded only when it moves from the break-out area to the segregating area. When the clamp truck returns to the break-out area it will travel empty--possibly by-passing some of the blocks of bales waiting to be transported to storage.

In this situation the waste travel involved frequently can be greatly reduced by combining the two operations of transporting bales to the segregating room and transporting newly received bales to storage, thus utilizing the clamp trucks for carrying bales in each direction. By making more effective use of the transporting equipment, the efficiency of both operations can be increased and the handling costs for each operation thereby reduced.

It should be recognized that, in case these transporting operations are combined, more time would be required to complete the segregating operation but no change would be made in the amount of transporting equipment used. In many cases, the additional time required will be relatively insignificant. That is, <u>both</u> operations frequently will be completed in only a little more time than would have been required to complete the <u>one</u> operation.

However, if speed in bringing bales to the segregating room is considered to be important, and if it is felt that combining the two operations would unduly slow the segregating movement, the solution is not to carry on the segregating operation apart from the movement of bales to storage (which wastes half of the travel time of the transporting equipment), but to apply more labor and equipment to the combination of the

two operations. For example, if when a single clamp truck works on one movement at a time, 60 minutes are required to complete the segregating movement and an additional 60 minutes to complete the storing movement for a certain number of bales—or 120 minutes for both movements—and if when the segregation and storing movements are combined so that the clamp truck works on both operations concurrently, 80 minutes are required to complete <u>both</u> operations; the most efficient way to reduce time required for either the segregation movement or the storing movement is to use additional clamp trucks on the combined operations. For instance, the time would be reduced by one-half, or from 80 minutes to 40 minutes, if 2 clamp trucks were used, which represents less time (and correspondingly lower costs) than would be required for either operation before the two operations were combined. Since each clamp truck added to the job reduces proportionately the total time required to complete the operation, increased speed of movement can be obtained by assigning additional trucks to the task. This can be done without increasing the <u>cost</u> of the movement. 7/

Possible combinations of operations are not, of course, limited to combinations of segregating and storing movements. Almost any two operations involving movement of different groups of bales in opposite directions may, under appropriate circumstances, be combined to advantage. It may be possible, at times, for the loading of a railroad car to be combined with a movement of a block of bales near the car to any point near or on the route between the car and the location of the bales that are to be loaded. Such a combination would be worth while whenever either haul, if performed apart from the other, would involve lengthy empty return trips. Moreover, reductions of empty hauls when tractor-trailer trains or hand trucks are used are also possible by appropriate combinations of operations. However, if in a particular hand-truck transporting operation some empty hauls are necessary to relieve fatigue of the hand truckers, this fact should be taken into consideration in planning combinations or other changes intended to reduce the relative amount of travel.

3. <u>"If the operation is combined with another operation, can it be separated to advantage?"</u> As previously pointed out it is often advisable to separate rather than combine cotton-handling operations. The desirability of separating operations stems from the fact that at present many cotton warehouses <u>group</u> certain operations and perform them under conditions which, by the very nature of the combination, result in waste and inefficiency. Perhaps the most common example is in the receiving of cotton. When hand trucks are used for all transporting, the unloading,

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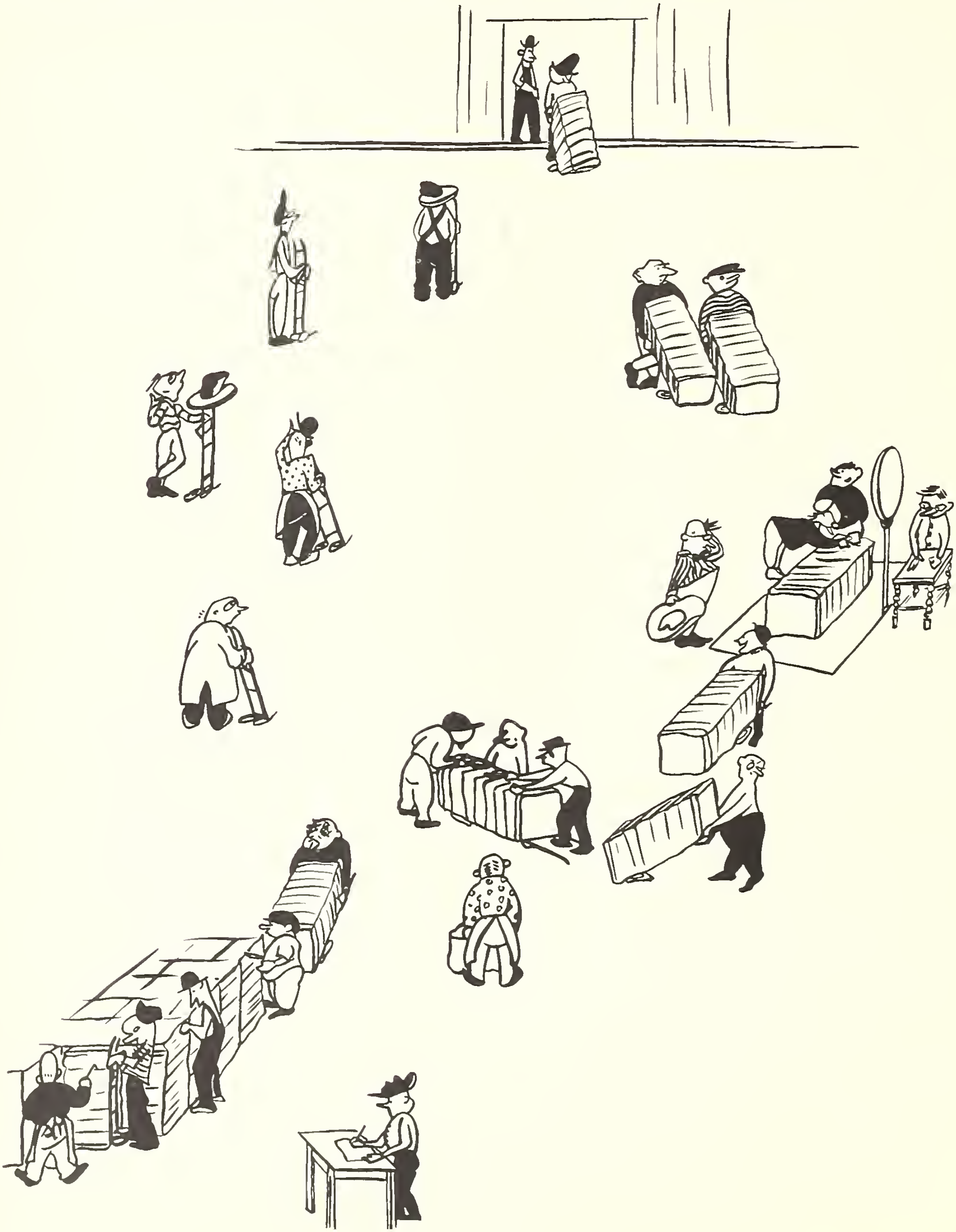
7/ In this situation it is assumed that the addition of one or more clamp trucks would not result in delay or wait time for such trucks, as might occur if interference developed between their movements. As a rule it cannot be assumed that doubling the size of the crew or the number of crews necessarily doubles the amount of productive work.

weighing, sampling, transporting to storage, and storing of bales are customarily combined into a cycle of operations with each bale being passed from one operation to the next by hand truck. Bales remain on the hand truck until the complete cycle from unloading to storing has been completed.



When these operations are tied together in this manner by the flow of bales from one operation to another, bales can be passed through the entire cycle at a rate no faster than the rate at which they can be passed through the slowest operation. As a consequence, every operation in the cycle proceeds at the rate of the slowest operation, which creates wait time throughout the cycle among workers otherwise able to perform their duties at a faster rate. Any significant delay occuring in one operation is passed on to succeeding operations in the cycle. Moreover, the equipment used in one operation in the cycle is often carried forward for use in other operations when a different type of equipment would be more efficient. The method used in one operation may also influence the choice of methods for other operations, frequently resulting in the choice of a less efficient method.

In such a situation it is usually advisable to separate the operations, making each independent of the others. Thus, each operation progresses at the maximum rate, without being slowed by delays in other operations. Also the economies of a more efficient organization of work may be realized, and the most effective equipment and methods used.

A means of separating operations is to place bales in a temporary block on completion of each operation instead of passing them directly on to the next operation. A temporary block between each operation in a cycle effectively separates each operation from all other operations in the cycle so that efficiencies become possible which could not be obtained under a system of interdependent operations. For example, the use of temporary blocks between operations in the receiving of a railroad car of flat bales at a warehouse makes possible the reorganization of the entire cycle of operations so that the equipment best adapted to each operation can be used. Under such a reorganization, the operations might proceed as follows: (1) Bales are unloaded from the railroad car by clamp truck and placed in a temporary block nearby; (2) the bales are later removed by hand truck from this temporary block, transported a short distance to a portable platform scale which has been located adjacent to the block, weighed, and returned to the same block or placed in another block nearby for sampling; (3) the bales are sampled while in this block; (4) the bales are removed from the block by clamp truck and transported to storage. When the operations are performed by these methods, substantial savings in labor usually result in comparison with methods under which the operations in the cycle are linked together by the direct flow of bales, by hand truck, from one operation to the next. Not only is it possible to increase the production rate of most of the operations by performing them independently, but the higher rate can often be achieved with a smaller crew. 8/

8/ The application of temporary blocks to receiving operations is described in greater detail in the report entitled "Some Improved Methods for Receiving Bales of Cotton in Compresses and Warehouses." By Jo Brice Wilmeth and Charles D. Bolt. Agr. Info. Bul. No. 80. U. S. Dept. Agr. Prod. Mktg. Admin. March 1952.

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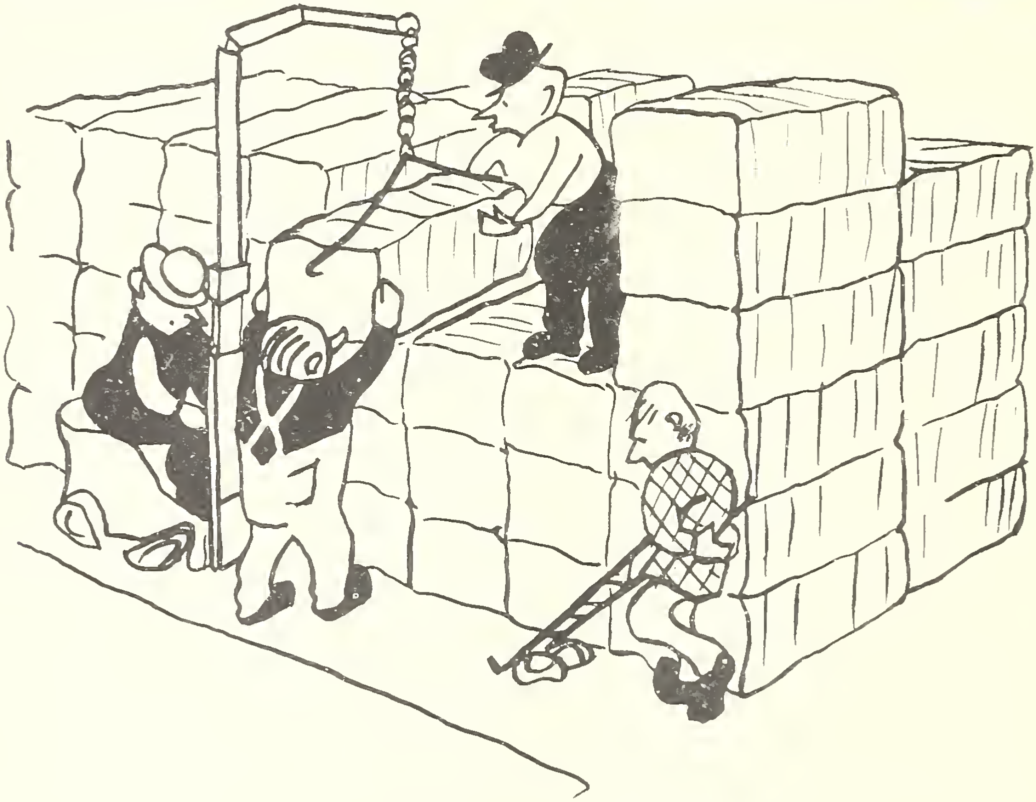
Another example may further illustrate the desirability of separating two operations which had previously been combined. At many warehouses where bales are stacked several layers high, a crew of two or three men and a boom truck are used to break bales out of a stack, and a hand truck is used to bring the bales to the main aisle. The break-out crew begins at the main aisle and, with the boom truck backing along the lateral or feeder aisle, works down the feeder aisle toward the wall, breaking out bales as required along the way. As soon as a bale is broken out of the stack and placed on the hand truck, the hand trucker transports it to the main aisle. Where this method is used, it is necessary that the hand trucker work in conjunction with the break-out crew, since the bales which have been broken out must be removed from the feeder aisle before the boom truck can return to the main aisle and proceed to another stack. Observation of this break-out operation shows that the hand trucker spends most of his time waiting.



The hand trucker frequently is required to wait for the break-out crew to complete the breaking out of a bale. This often involves waiting while several other bales in the stack are handled in gaining access to the desired bale. Time studies of such operations show, in fact, that in many cases the hand trucker works less than 20 percent of the time he is on the job.

To improve this operation, a method was suggested which involved separating from the break-out operation the operation of hand trucking bales to the main aisle. By use of the suggested method the boom truck enters the feeder aisle, boom first, and proceeds immediately down the aisle to the wall. The bales nearest the wall, rather than those nearest the main aisle, are then broken out first. The boom truck and break-out crew then work from the wall toward the main aisle, leaving the bales that have been broken out in the feeder aisle.

Upon reaching the main aisle the break-out crew proceeds immediately to the next stack and repeats the cycle. <u>At a later time</u> one or more hand truckers (or, where suitable, powered lift trucks) remove bales from all the feeder aisles and place them in the main aisle.

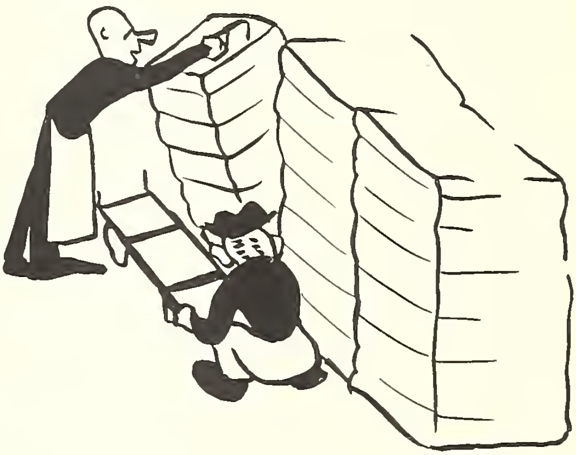
As before, the bales may then be carried by tractor-trailer train or clamp truck to the press room or shipping area.

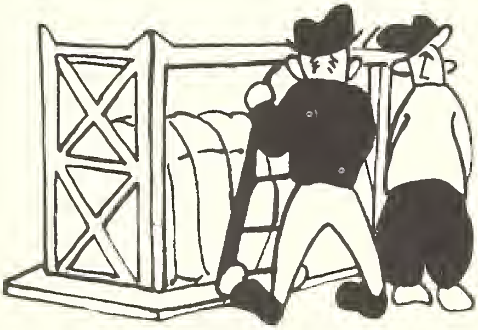
By thus separating the activities of (1) breaking the bales out of the stack, and (2) transporting them to the main aisle, the hand trucker is provided with constant work, and the idle time spent waiting for bales to carry is eliminated. During the time saved the hand trucker is available for other work.

4. "Can a better sequence of operations be used?" Economies can often be effected by performing an operation or an activity at a different time or place, so that a sequence of operations becomes better balanced and idle time is reduced. It has been pointed out how in one case a warehouseman had a second sample drawn before, rather than after, a bale was placed in storage. Under a particular situation existing at the time, this change in sequence eliminated the necessity of costly resampling.

Another example, in which a change in sequence resulted in a saving of labor, is as follows: Normally, in a compressing operation where bales are transported by hand truck from a temporary block to the dinky press, and are fed into the dinky press by the hand trucker, it is necessary to use a pull-down man at the block to assist in placing each bale on the hand truck.

The pull-down man sees that the bale is properly placed in an on-side, rather than on-head, position on the bed of the hand truck,



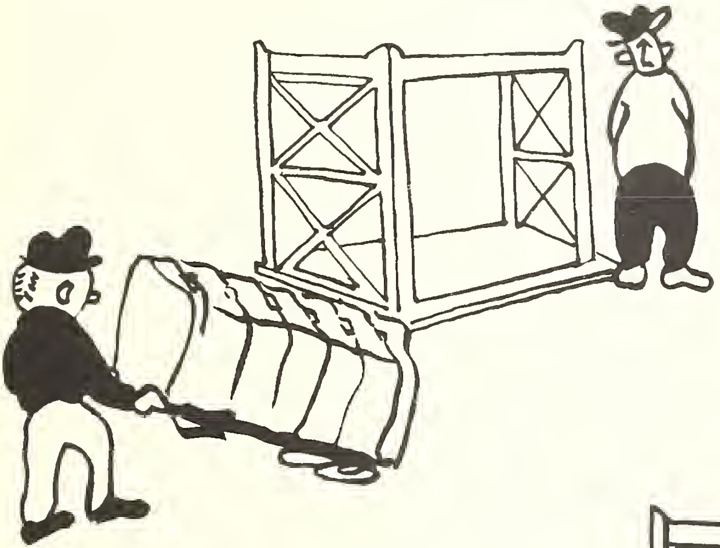


so that the hand trucker will be able to throw the bale directly forward into the dinky press.

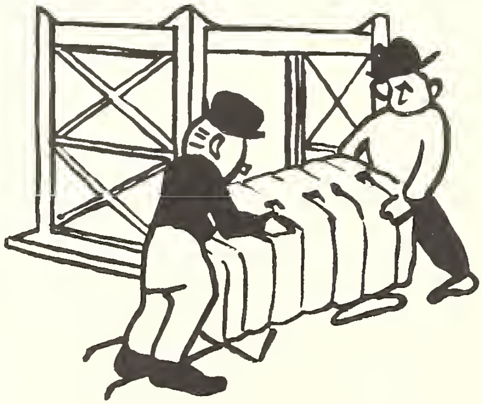
One warehouseman eliminated the pull-down man at the block by a method which provided for the "positioning" of the bale at the dinky press instead of at the block.

Under this method the hand trucker picks up a bale <u>on head</u> at the block,

and carries it to the dinky press. However, he approaches the press from the side, rather than the front, so that the bale is in a position to be moved from the hand truck into the dinky press.



One of the two men at the dinky press (the second man is not shown) works with the hand trucker in placing the bale in the press.



Since this man has other duties which require him to be at the press and since these duties cannot be performed until a bale is actually in the press, he is always free to assist in positioning a newly arrived bale. Thus, when the bale is positioned for the dinky press at the press rather than at the block, the labor of one man is saved with no loss of speed in feeding bales to the dinky press.

5. "Can the operation be simplified?" The physical operation of weighing a bale is simplified when the automatic dial-type platform scale is substituted for the standard beam scale. The bale no longer has to be lifted from the hand truck for weighing, and this eliminates the need for hook men and a rope man. Moreover, it is no longer necessary for the weigher, on each weighing, manually to position the poise on the weigh beam at a point where a "proper balance" is obtained. As a consequence workers with less experience can be used as weighers. Thus, it becomes possible to weigh bales not only with fewer, but with less skilled, workers.

A portable platform scale often makes possible a simpler weighing operation than a stationary platform scale. The portable platform scale can be brought to the bales to be weighed, thus reducing the number of hand truckers required for efficient operation, and making it easier to control and coordinate the activities of both the hand truckers and the scale crew.

Two Suggestions for Locating Trouble Areas

Two general techniques for locating trouble areas may be applied to cotton-handling operations:

1. Observe the entire operation, or an entire sequence or cycle of operations, over an extended period of time. Such observations frequently mean, in effect, observing a whole crew at one time. As a rule, several hours should be spent in observation, carefully noting every detail of the job. In observing the work of a crew in performing an operation or a cycle of operations, look especially for bottlenecks that tend to delay or slow the operation. Bottlenecks are often found by noting at what places too many men, particularly hand truckers, are backed up waiting in line. This situation may indicate a source of delay. Just as important as bottlenecks, however, are areas where men are standing around waiting for work. This condition may result from a bottleneck in a preceding operation in a cycle of operations, or it may result from lack of balance in the crew at the point where the waiting occurs. The reasons for either condition must be determined.

2. Observe continuously for several cycles an individual worker on the job. Look for excess idle time, owing either to waiting in line at some point or points in the operation, or to waiting at a fixed station for work to arrive. This procedure should be applied to only one worker

at a time, but as many workers as possible should be studied in this way before coming to a conclusion to take action.

Importance of Noting Delay Time

The importance of noting where waiting, or delay, time occurs cannot be overstressed. The fact that delay time exists indicates that man-hours of labor are being wasted; the particular points at which delay time occurs are often a key to its cause and an indication as to what kind of remedy might apply. A common cause of delays in cotton handling is, as previously shown, the interdependence that exists among many operations. Examples of this, as has been pointed out, are found in combinations of receiving operations, of break-out and transporting operations, of compressing and loading operations, and in other areas.

It is not always necessary to _time_ the amount of delay. Frequently, it is important only to know: (1) That delay time exists; (2) that there are specific causes for it; and (3) that it is large enough and costly enough to warrant taking steps to remove or reduce it. These facts often may be learned by observation alone.

At other times it may be desirable or advantageous to have a more accurate estimate of delay time than could be obtained solely by observation. In such cases delays should be timed, preferably with a stop watch. A stop watch not only permits greater accuracy than an ordinary watch but, for the purpose of timing elements and delay factors in an operation, is much easier to use. Although a high degree of accuracy may not be required in time measurements made for the purpose of planning an improved method, the stop watch is often more convenient than an ordinary watch. A device, available on many stop watches, which permits delay time (or any time measurement) to be _accumulated_ as it is observed throughout an operation, is especially convenient. When this device is to be used in timing delays, it often will be desirable to use a second watch (here an ordinary watch usually will be satisfactory) to obtain the over-all elapsed time for the operation. At the conclusion of the observation period, the accumulated delay time (obtained by the stop watch) may be compared with the over-all elapsed time (measured by the other watch) to estimate the proportion of total time accounted for by delays.

Other than use of the accumulative timing device, there are at least two ways in which delays may be timed, either with a stop watch or an ordinary watch. When either an individual or an entire crew is studied, one method is to record the start and stop times of each delay observed. However, this method is not entirely satisfactory if at times only a part of the crew is idle. In such cases it is not possible to determine from time readings alone the total man-hours wasted in delay time. A second method, which does not have this shortcoming, is to record the _number of men idle_ at a particular time. The first time to be recorded is that

made at the beginning of the observation; if any workers are idle at that same instant of time, their number is also recorded. Thereafter, recordings are made only as the number of idle men changes, and as the observation is concluded.

Comparing the Efficiency of Two Methods

If study of an operation along lines suggested results in the development of an improved method, it may be desirable to know how much more efficient the improved method is than the original method. Sometimes it is possible to estimate the relative efficiency of the new method fairly closely before it has been tried. An estimate may indicate whether it is worth trying. However, the only true test of a new method is to determine how it works in practice after the workers have developed an ability to do the work smoothly.

Time studies of both the original and the improved methods afford the best basis for appraising the two methods. Whenever time studies cannot be made, the over-all elapsed times recorded for each of the methods in handling a specified number of bales may serve the purpose. The chief danger in using over-all times is that certain delays and other factors which should not be counted as part of the productive time required may be included. If necessary to achieve comparability, the observed times may be adjusted for differences in worker performance, for fatigue allowances, and the like.

The time required for the performance of an operation, multiplied by the number of men engaged in performing it, provides the total man-minutes or man-hours of labor required. Thus, an operation that is performed in 2 hours by a crew of three men requires 6 man-hours of labor.

As previously indicated, efficiency may be measured in terms of the number of bales handled and the man-hours required to handle them. This relationship may be expressed as the number of bales handled for a specified number of man-hours of labor expended, or as the number of man-hours of labor required to handle a specified number of bales. Either type of measure may be used, according to preference or convenience, in a comparison of two methods. Thus, the method under which more bales are handled with a given amount of labor, or a given number of bales with less labor, would be regarded as the more efficient of the methods compared.

SOME MATERIALS-HANDLING PRINCIPLES AND THEIR APPLICATION TO HANDLING BALES OF COTTON

Materials handling, including the handling of cotton, is perhaps as much an art as it is a science. The same is true of production scheduling, work organization, methods improvement, and many other activities in which man himself--either as the planner or designer who decides what is to be done or as the operator or doer who carries out the job given to him--plays a prominent part.

The scientific nature of these activities is shown by the fact that it is possible to formulate a set of "principles," mutually agreed upon and accepted, which represent the rules that are to be followed. It is the application of these rules or principles to particular problems and situations that is an art.

This section sets forth a number of principles applicable to the handling of cotton which, if followed, should result in efficient and economical handling. The rules are based largely on established principles of materials handling and principles of work organization which have been developed and tested over a period of many years, in many industries, and under varied conditions. The basic principles have been developed and established, and these principles are accepted by the industrial engineering and management engineering professions. The task of the authors has been to interpret the basic principles in terms of the warehousing of cotton, and to illustrate, by means of examples based on research, the application of these principles to certain types of cotton handling problems. The warehouse manager or his foreman must interpret these principles as they apply specifically to his own problems. It is the cotton warehouseman, then, who has to be the artist in the undertaking.

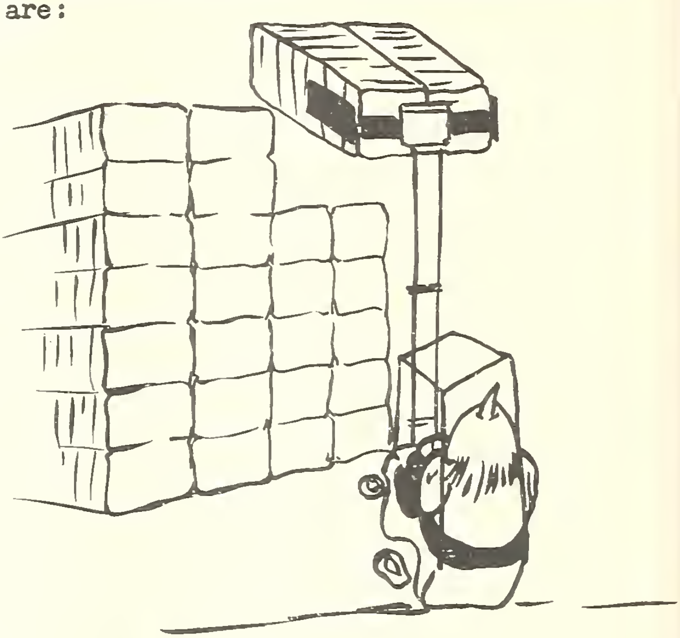
Mechanization Principle

Efficiency and economy in handling and warehousing cotton result from using powered mechanical equipment in place of manpower wherever practicable. This principle means simply that, as a general rule, the use of clamp trucks, fork trucks, tractor-trailer trains, and other powered equipment results in more efficient and, where the volume of bales handled in a season is large enough, more economical handling than is possible when manpower is used without such aids.

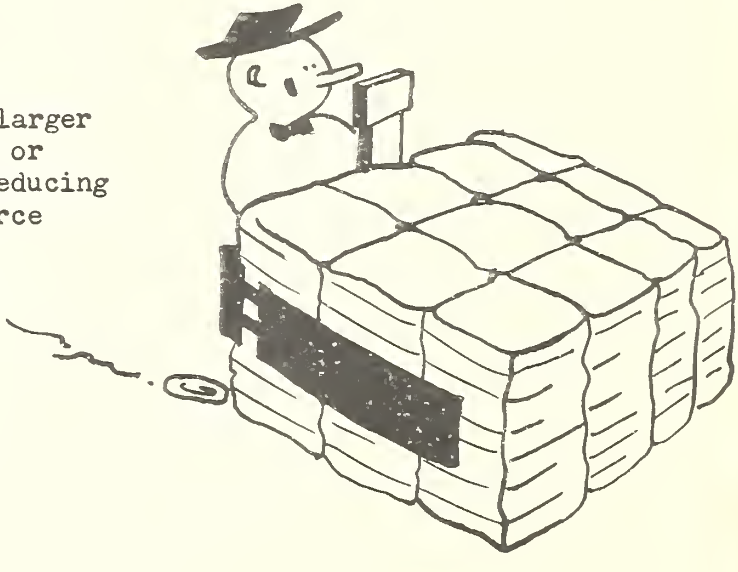
One important advantage of mechanized equipment is that it increases the speed or rate of handling. For example, most tiering operations are performed much faster by machine than by manual methods. Moreover, although industrial lift trucks have been designed primarily for tiering operations, it has been demonstrated that clamp-type lift trucks are superior to manual and hand-truck methods not only for loading and unloading of railroad cars and motortrucks and stacking and breaking out cotton (operations in which the tiering properties of the truck are important) but

also for transporting. Yet the hand truck, rather than the lift truck, was primarily designed for transporting. From time-study and cost analyses, however, the transporting of bales by clamp truck was shown to be not only faster but generally cheaper than that by hand truck, for even the shortest practical distances.

In addition to increased speed and decreased cost of handling, other advantages of mechanical handling are:



1. Bales can be economically stacked higher than when stacked manually or by use of elemental types of equipment, thus making the most effective use of floor space. Storage space that might otherwise be wasted can be utilized.

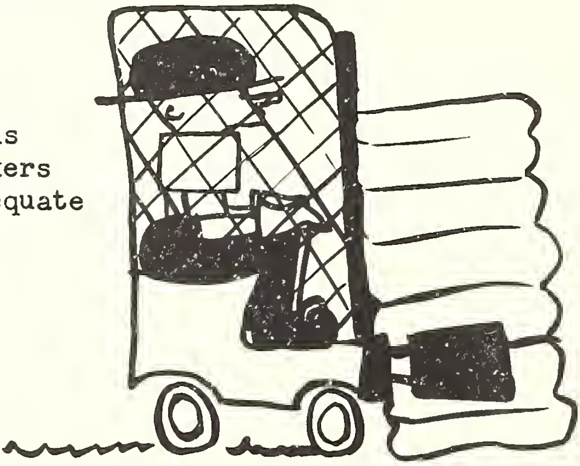


2. Bales can be handled in larger unit loads (2, 4, 6, 12, or more, at a time), thus reducing the size of the labor force required.

3. Fatigue is reduced. Handling bales manually is hard and tiring work. When powered equipment is used, workers become less fatigued and maintain their efficiency longer.

4. Generally, the safety of handling operations is increased by reducing the manual handling of bales, especially under the somewhat dangerous conditions often encountered in loading and unloading tiered bales, in stacking, and in breaking bales out of stacks.

Obviously, proper safeguards must be provided to protect workers using the equipment (such as adequate overhead guards on lift trucks).



Also, appropriate rules of safety should be followed. (Some of these rules are covered later in this report.)

Standardization Principle

Maximum economy calls for the finding and use of the best method for each type of handling operation under particular conditions. This principle is related to finding the "one best way" for doing a particular type of operation (such as unloading tiered flat bales from a stake-type motortruck at ground level) and using that way every time for the same type of operation. The one best way is usually defined as the method that gets the job done in the shortest time, with the least effort, and at the lowest cost.

The best method of doing a job implies the use of the most suitable and most effective type of equipment. In the cotton warehouse industry, where mechanical equipment has been introduced on a large scale only within recent years and where there are many unsolved handling problems, it is sometimes more difficult to standardize on equipment than in some other industries. Standardization ordinarily implies the selection of the smallest practical number of different types and sizes, if not the selection of one type and size of equipment. Some warehousemen, who attempt to find out by experiment what are the best types of equipment for their handling operations, try many different models and designs of equipment and various types of innovations in handling devices. Where resources are adequate to support this type of experimentation, there is much to be said for it. Most warehousemen, however, would probably find it advantageous to choose the simplest and most effective equipment considered "standard" in its field, and then to use that equipment more or less exclusively. As a rule, special equipment should be used only under special circumstances. Moreover, if several units of the same type and size of equipment, such as lift trucks, are used, the stocking of repair parts is more economical and skill in servicing and in making repairs can be acquired more quickly than otherwise would be possible.

Adaptability Principle

The greater the variety of cotton-handling operations for which a particular type of equipment can be used, the greater is its value to the warehouseman. Some types of equipment are much less adaptable than others. Although hand trucks are useful as levers for breaking bales out of their positions in stacks or in railroad cars and as rams in positioning bales in a block or in a railroad car or motortruck, their principal use is for transporting and their effective use for other purposes is limited. Since current models of cotton scales are being designed for use with hand trucks, weighing is one type of operation in which the hand truck is most useful as transporting equipment. For most, if not all, other transporting operations, however, the hand truck is less efficient than powered equipment. Even in weighing, hand trucks can be eliminated by using the mobile beam scale, or if, as has been done in a few plants, clamp trucks are used to transport bales to and from platform scales.

The tractor-trailer train is, of course, limited entirely to transporting; it cannot weigh, load, unload, or stack bales.

The use of the boom truck (an industrial lift truck equipped with a boom attachment) is limited mainly to stacking and to breaking bales out of stacks, particularly where compressed bales are stacked in cordwood manner, and where lateral or feeder aisles are too narrow for other powered equipment. The boom truck is sometimes used for loading and unloading motortrucks and for loading railroad cars, but it is less efficient for this purpose than other equipment. It has little or no value for transporting bales.

Clamp trucks of 2- or 3-bale capacity are perhaps the most versatile of powered equipment. They can be used efficiently in loading and unloading operations, in many stacking and breaking-out operations, and for transporting. Small fork trucks (1,000-pound capacity) used in a number of smaller cotton warehouses, are not only less versatile than clamp trucks (for instance, they are of relatively little value in transporting bales except under unusual circumstances) but in most bale-handling operations they are usually less satisfactory and less efficient. However, small fork trucks often are useful in warehouses where the floors and platforms will not support the weight of the heavier equipment.

Other attachments, such as the upender, the revolving clamp, and the Garrett break-out device, recently introduced into cotton warehouses, show promise of increasing the flexibility of the industrial power truck. With certain models of lift trucks the time required to change from one type of attachment to another has been materially reduced.

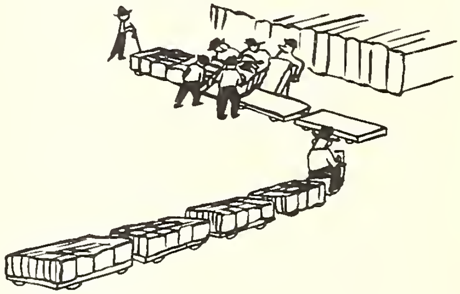
Equipment in Use Principle

Economies in handling cotton are increased by decreasing the proportion of idle time to use time of the handling equipment. This principle stems from the fact that an item of handling equipment is of value to a warehouseman only when it is in use. This fact would appear to be obvious. However, several instances have been found where equipment was deliberately withheld from use, or used sparingly, to "save" operating costs and to prevent the equipment from "wearing out."

Such a policy shows misunderstanding of how handling economies are achieved. In one case, where a railroad car was loaded manually while a lift truck stood idle, the warehouseman defended his policy by pointing out that the workers were on hand, and would have to be paid whether they worked or not. Although at many warehouses situations sometimes arise in which the waste of either equipment or labor is difficult to avoid, any general practice of using labor in place of equipment merely because labor is available will usually tend to create (or perpetuate) a situation in which on the average more workers are kept on hand than are really required for the work to be done. Also, the warehouseman should remember that just as workers who are on hand must be paid regardless of whether they are assigned work to perform, the costs of owning the equipment continue regardless of whether the equipment is used. Moreover, when workers must do back-breaking work, such as topping a car by hand, while a machine that can do the job is idle, poor labor relations are likely to result.

From the principle that equipment should be utilized as fully as possible, it follows that if any two or more items of equipment used in conjunction with one another must remain idle for any sustained period, the idle equipment should be the less valuable equipment. For example, in the operation of a tractor-trailer train system the tractor should not be held up at loading and unloading points while the trailers are being loaded

and unloaded. A tractor is designed to pull trailer trains. More effective use can be made of tractor-trailer train equipment when enough separate trains of trailers—the less expensive parts of the equipment--are used with one tractor to permit the tractor to continue in motion while trailers are halted for loading and unloading. Ideally, the transporting operation should be so organized that the tractor is always busy pulling a train of trailers between the two terminals while one train is being loaded at one end and another train is being unloaded at the other end. The trailers are allowed to remain at the terminal points of haul until the tractor returns to pick them up.



Another efficient system is to use a single clamp truck to load bales onto a train of trailers, pull the trailers to the unloading point while itself carrying a full load of bales, unload the bales, and return with the trailers to the loading point to repeat the cycle.

Equipment Velocity Principle

The economy of handling cotton usually is increased as the velocity of the handling equipment is increased. As noted previously, the higher speed or velocity of a clamp truck is an advantage over the hand-trucking of bales. The speed of a clamp truck, both in transporting and in tiering, is part of its capacity to produce. The greatest value is obtained from a machine when it is used to--but not in excess of—its full rated capacity. When operated at less than rated speed, production suffers and costs per bale rise. Some warehousemen, however, for safety reasons, or to save wear and tear—and presumably repairs--on the equipment, require their lift truck drivers to operate their equipment at very slow speeds. Of course, equipment should never be operated at such a speed or in such a manner as to create safety hazards. It is doubtful, however, if speeds slower than the limits imposed by safety considerations save enough on repairs to compensate for the loss in production that results.

Size of Load Principle

Economy in handling cotton is increased as the number of bales in the load is increased. The application of this principle is best illustrated by operations in which a clamp truck is used. A clamp truck can handle as a unit two or more bales. In contrast, a hand truck can handle only one bale at a time.

This limitation, together with its slower speed, causes the hand truck to be relatively inefficient for transporting.

Most clamp trucks in use in cotton warehouses today normally carry two bales.

Others normally carry 3, 4, 6, or more bales.

The number of bales carried varies according to the nature of the operation being performed, type and capacity of the transporting equipment, type of bales (flat, standard density, or high density), and arrangement of the bales making up the load.

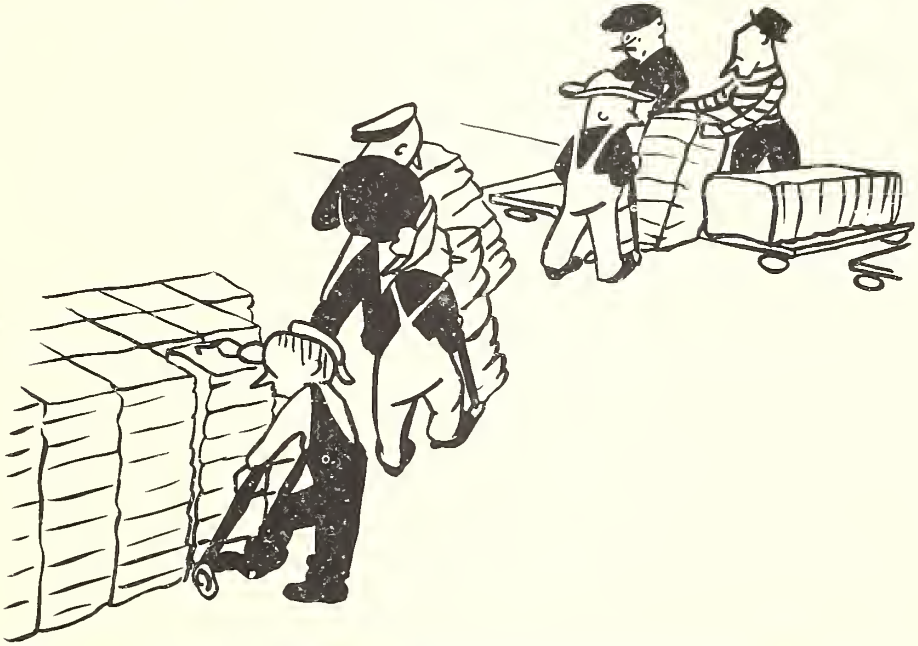
As the size of the load carried by a clamp truck is increased (provided the load does not exceed the rated capacity of the truck), the greater are the savings that may result. Obviously, the more bales carried on each trip, the fewer the trips and the shorter the time required to complete the movement. Under some circumstances, in fact, the rate of delivery of bales may be increased more by using equipment which handles large loads at a slow speed than by using equipment which handles smaller loads at a faster speed. Of course, the size of the load cannot be increased without limit. In addition to the factors already mentioned as influencing the size of the load carried by a clamp truck, other factors, such as floor load limits, widths of aisles and platforms, and heights and widths of doors, limit the number of bales that it is economical or practical to handle as a unit. For example, in the loading or unloading by machine of most rail cars of current designs, it usually is impracticable for the clamp truck to carry more than two flat bales or three compressed bales at a time. Although such load limits are usually determined by the width of the car door, the type and capacity of the equipment, or the type of clamp attachments available, in many cases a more effective limitation is the difficulty of maneuvering larger loads within the car. Sometimes the condition and load limit of the car floor are also limiting factors. In many operations where such restrictions do not apply, larger unit loads frequently may be used to increase efficiency. For example, at some of the larger warehouses savings have been achieved by using 6,000-pound-capacity clamp trucks to load and unload motortrucks from ground level by employing 6-bale unit loads. In other words, bales are loaded onto or unloaded from the motortruck six at a time.

The point should be emphasized that savings realized from the use of <u>unit</u> loads are multiplied as these unit loads are carried forward into other operations. The loading and unloading of a car or motortruck, where the transport of unit loads (two or more bales) from or to a temporary block is combined with the loading or unloading of the same unit loads, are examples. Another common example is where a clamp truck stacks two or more bales as a unit as a continuing part of its delivery of such unit to the storage area.

Although the use of clamp trucks to handle two or more bales as a unit makes possible many handling economies, especially when such unit loads are carried through a series of operations, still larger loads—though not necessarily unit loads—are often carried by other types of equipment. A tractor-trailer train, for example, usually carries from 9 to 16 bales on each trip. Under certain circumstances some trailer trains may carry as many as 50 bales on each trip. On long hauls a <u>single</u> tractor-trailer train is capable of transferring bales at a faster rate than would be achieved by a <u>single</u> clamp truck carrying 2 or perhaps more bales at a time. This speed advantage usually holds in spite of the fact that in some cases most of the time required in hauling by

tractor-trailer train is spent in loading and unloading the trailers. However, it should be noted that the speed advantage of the tractor-trailer train (whether operated as single or multiple units) over the clamp truck may be decreased or entirely overcome as clamp trucks of larger carrying capacity are substituted, or as additional clamp trucks (whether of larger or smaller carrying capacity) are assigned to the transporting operation.

A serious disadvantage of tractor-trailer train operations as they are performed in many cotton warehouses is that they are conducted in such a way as to be more costly than other means of transporting bales. In many such cases even the hand truck is less expensive for some of the shorter hauls on which the tractor-trailer trains are used. The chief reason for the relatively high cost of these tractor-trailer train operations is the inefficient loading and unloading methods used. It is not uncommon to see from 3 to 8 men loading the trailers manually



and another crew of about the same size unloading them manually. Some of the workers at the loading point hand truck bales from a nearby block to the trailers and others assist in placing the bales on their sides on the trailers. At the unloading point bales are manually removed from the trailers by some of the workers and hand trucked by others to a block. Where these methods are used, frequent delays and wait time for many crew members are almost inevitable. In addition to the wait time between trains, during which time most of the crew members may be idle, frequent periods of waiting for some crew members usually occur during the loading and unloading operations. Much of this waiting results from the difficulty of synchronizing and coordinating the work of the loading and

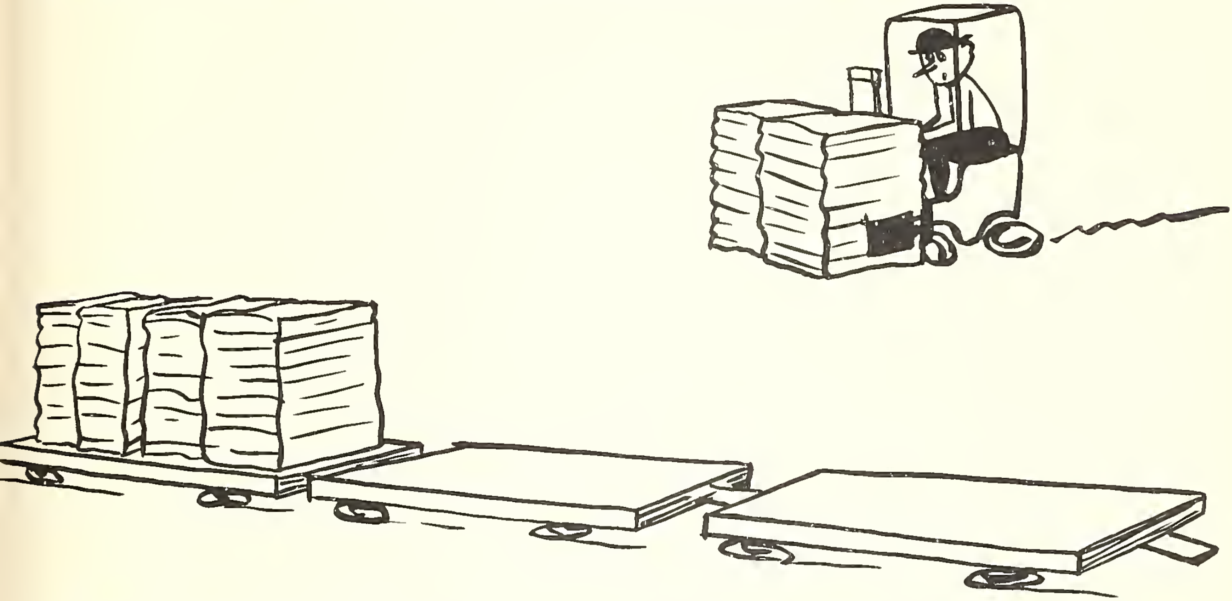
unloading crews and the different activities of the individual members of each crew. The fact that so much manpower is thus tied up in loading and unloading trailers causes the total cost of the tractor-trailer train operation to be unduly high.

The key to improving tractor-trailer train operations of the type just described is to employ, or to find, more efficient ways of loading and unloading trailers. Several warehouses are now using clamp trucks in place of hand labor to load and unload trailers. Since bales normally are carried on side on the trailers to permit a larger load to be carried or to obtain greater stability of the load, it usually is necessary for the clamp truck performing the loading to reposition bales from an on-head to an on-side position just before or while in the process of placing them on the trailers, and the clamp truck performing the unloading to reposition the bales on head before placing them in the block. This repositioning of bales usually requires additional time in loading and unloading the trailers, although where specially skilled clamp truck operators are used, the repositioning of bales is accomplished very quickly.

A few warehouses are now experimenting with the "upender" clamp attachment, which permits the position of bales to be changed while they are being carried by the clamp truck,

thus avoiding delays for repositioning. The value of the upender clamp when used for this purpose is not yet fully known.

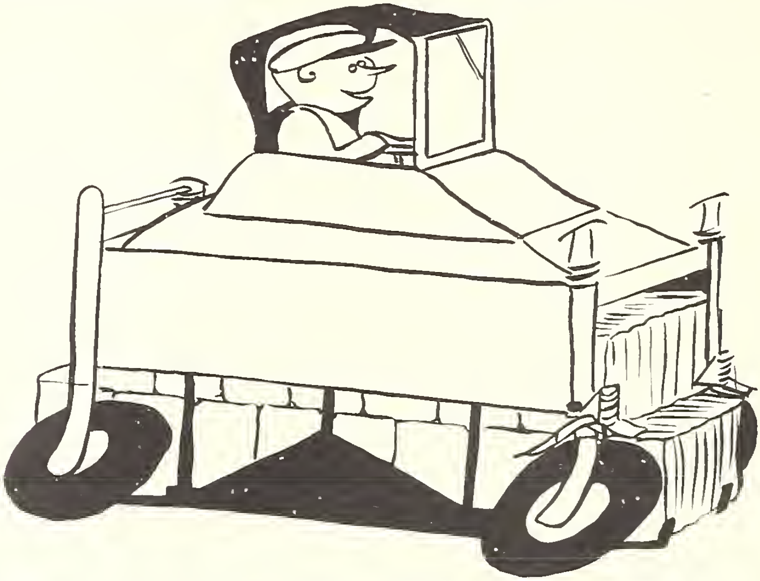
If excessive speed in making turns is avoided, it often will be possible to carry flat bales on head on trailers, with little or no risk of bales falling off in transit. Obviously, if bales are carried in an upright or on-head position on the trailers, trailers could be loaded or unloaded by a clamp truck with a standard clamp attachment, without involving any loss of time for repositioning bales.



In cases where the floors are unusually rough or uneven or many sharp turns are involved in travel, it may be advisable to equip trailers with suitable guards or supports to allow the bales to ride securely. At one warehouse a supporting bar and a chain were built onto each trailer so that compressed bales could be carried on head, thus permitting rapid loading and unloading of trailers by machine.

The particular types of supports used were not entirely satisfactory, but the idea itself appeared to have considerable merit.

To transport high-density bales from the warehouse to the wharf area, one port warehouseman now uses straddle trucks.



This transport, involving a haul of about 2 miles, was formerly by tractor-trailer train. Advantages of the straddle truck in this operation are its fast load-pick-up and load-set-down times (usually totaling less than half a minute for both) and its greater speed (up to 40 miles an hour on the open highway). The straddle trucks used at this warehouse are able to carry 15 bales in each load. Although this is not as large a load as might be desirable, it is as large as is practical under present conditions at this port. Trial operations at other ports have indicated that larger straddle trucks, operating under more favorable conditions, might be able to carry loads of 50 or more bales.

Combination Principle

Economy in handling cotton is increased when two or more otherwise independent operations, or parts of such operations, are combined in such a way as to convert empty or waste travel for one operation into loaded or productive travel for the other operation. An example of this principle, wherein the transporting of cotton to a press segregating room by clamp truck was combined with transporting bales to storage, was discussed on pages 31-33.

Separation Principle

Economy in handling cotton is increased when two or more interdependent and simultaneously conducted operations, linked together by the flow of individual bales in succession from one operation to the next, are separated by means of temporary blocks of bales. Such breaks between operations make it possible to do the operations independently. Two examples of the application of this principle were discussed on pages 33-38.

Shortest Route Principle

Economy in handling cotton is increased if bales are moved from one point to another by the shortest route. This principle simply means that travel distance should be kept to a minimum. The point should be obvious to all warehousemen. Yet some warehousemen often appear to be unconcerned as to whether their transporters take direct routes to their destination or whether they take roundabout routes which result in substantially higher transporting and handling costs.

An operation observed at one warehouse, though an extreme and perhaps over-simplified example, illustrates how handling costs may be increased when, through lack of proper supervision or otherwise, workers are permitted to ignore this principle. This operation involved the loading of a railroad car, with bales being brought to and loaded into the car by clamp truck. Three clamp trucks were assigned to carry bales from the segregating room to the railroad car because a travel distance of approximately 250 feet between the shipping block and the car (or a round trip of 500 feet) was involved on each trip. The travel distance could have been reduced to about 60 feet by the removal of 9 bales that blocked a passageway to the car. No more than 2 or 3 minutes would have been required to remove the 9 bales. Had this been done, the car could have been loaded in less time by one clamp truck, releasing two machines and two operators for other work.

Handling Aids Principle

Economy in handling cotton usually is increased by the provision of equipment and facility features to aid handling. Suitable operating equipment and proper facilities are often as effective savers of manpower as improved methods and advanced equipment. Such handling equipment features as ball-bearing wheels and casters, rubber tires, and automatic couplers on tractor-trailer trains, and such facility features as smooth floors, aisles, and platforms, and wide aisles and runways are aids to efficient handling. Also, there are many small or inexpensive items of supplementary equipment that are very useful in increasing handling efficiency. The use of a buck bar near the jib crane at the press, against which to place bales, was described previously. This is one example of how a relatively inexpensive item of equipment eliminated the need for

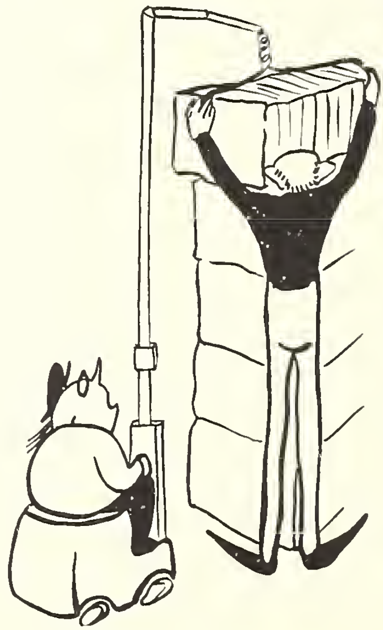
two hand truckers. A bridge plate sufficiently wide and long, and properly crowned, may be the means of saving labor in loading and unloading railroad cars. A scissors hook sometimes makes it possible for one man to do the work formerly done by two men in hooking bales for weighing and for stacking.

Proper Worker Assignment Principle

Economy in handling cotton is increased when individual workers are assigned to jobs for which their physical capabilities are best suited and for which they have an aptitude. Proper selection and assignment of workers to their jobs will often result in manpower savings. Unfortunately, many warehousemen give little or no attention to the problem of selecting the proper worker for the job.

When strength is required to do the job, a worker with plenty of muscle and a strong back should be used.

Likewise, at a task where height is a distinct advantage, a tall worker should be used.



There are many operations in a cotton warehouse at which persons of smaller stature can do an excellent job. For example, such a person might be useful as a lift-truck operator. In fact, women have proved themselves to be capable and efficient lift-truck operators in many industries.

Some cotton warehouses have for some time been using women on such work as hand trucking and sampling.

Balanced Operations Principle

Economy in handling cotton is obtained when, in operations involving crews of workers, the men and equipment are assigned in accordance with the minimum number of men required, and their work is so arranged that delay time and total man-hour requirements are kept to a minimum. Whenever two or more men work in combination with one another, whether on the same operation or on several related operations performed in sequence, their individual activities must be properly synchronized or "balanced" if waiting or delay time is not to result. A well synchronized or well balanced cotton-handling operation or cycle of operations is one in which the assignments of the individual crew members are so arranged and organized that each worker's duties in connection with each bale handled require about the same time to complete. To the extent to which the duties of crew members are not balanced, delay time will develop. Delay time results from the fact that in an unbalanced operation some crew members spend part of their time waiting while other crew members are completing their tasks. The opportunities for delay time to occur usually increase with the size of the crew, since as the number of workers increases it becomes more difficult to coordinate their activities. Therefore, although proper balancing of a crew may at times make it necessary to increase the number or proportion of workers performing a particular function, the total crew size should be determined in accordance with the minimum number of workers required.

The significance of delay time was pointed out previously and some types of operations in which delay times are commonly noted were discussed. Chief among these were receiving operations when carried on interdependently. The principal solution suggested for these and similar types of operations was the use of temporary blocks, since their use may reduce or eliminate certain types of delay time, many of which are owing to the difficulty or perhaps impossibility of obtaining a proper balance among the operations comprising the cycle. If such blocks cannot be used, however, or if, even with the use of temporary blocks, some operations are performed by several men working together, effort should be made to obtain the best balancing of activities possible. The number of hand truckers, for instance, should be adequate for the total distance traveled and for attaining the best rate at which bales are able to proceed through the entire cycle of operations. The break-out crew in the car, if used, should be small enough so that its own wait time is held to a minimum, yet large enough to keep hand truckers adequately furnished with bales.

There are some types of operations in which a crew of men may work together without creating any special problems of balance. Examples of these are simple transporting operations in which bales are moved from one area of the warehouse to another by two or more hand truckers or by two or more clamp trucks under conditions which permit each worker to perform his tasks without interference from other workers. Under such conditions waiting time would not arise even though the individual workers required different times to complete their duties.

However, since in many other types of operations balancing does become a problem when men work in combination with one another, it follows that whenever, through the use of mechanical equipment or otherwise, one worker can be substituted for a crew of two or more workers in such an operation (as where a clamp truck and operator are used alone to load or unload a railroad car), any waiting time due to lack of balance in the operation can be eliminated entirely. It is only through the complete elimination of such waiting time that it becomes possible to achieve maximum efficiency. In other situations, reduction to a one-man operation may not be practical; in such cases proper balancing of work is likely to be involved in any acceptable solution.

An example of how the balancing of the operation, on one hand, and avoidance of the need for balancing, on the other hand, represented alternative solutions to a specific handling problem is illustrated in the following observed operation: At one warehouse a 1-bale fork truck and a 2-bale clamp truck were used together to build a row stack of flat bales, two bales high on head. Beginning at the wall and working outward, the fork truck set out bales on the floor, and the clamp truck, approaching the row at right angles, placed bales on top of those deposited by the fork truck—that is, it "topped" the stack. Both the fork truck and the clamp truck brought bales from the same block so that each had about the same distance to travel on their respective trips. The

operation was unbalanced, however, because the clamp truck was able to carry two bales to every one bale carried by the fork truck. So before two bales—the product of one trip--could be topped by the clamp truck, two other bales--the product of two trips by the fork truck--had to be put in position on the floor. With this procedure the fork truck was always busy, but the clamp truck was idle about half of the time. A better operation might have been obtained:

1. By using two 2-bale clamp trucks together, rather than one clamp truck and one fork truck. This was the solution based on the balancing of operations. It would greatly reduce but might not completely eliminate waiting time.

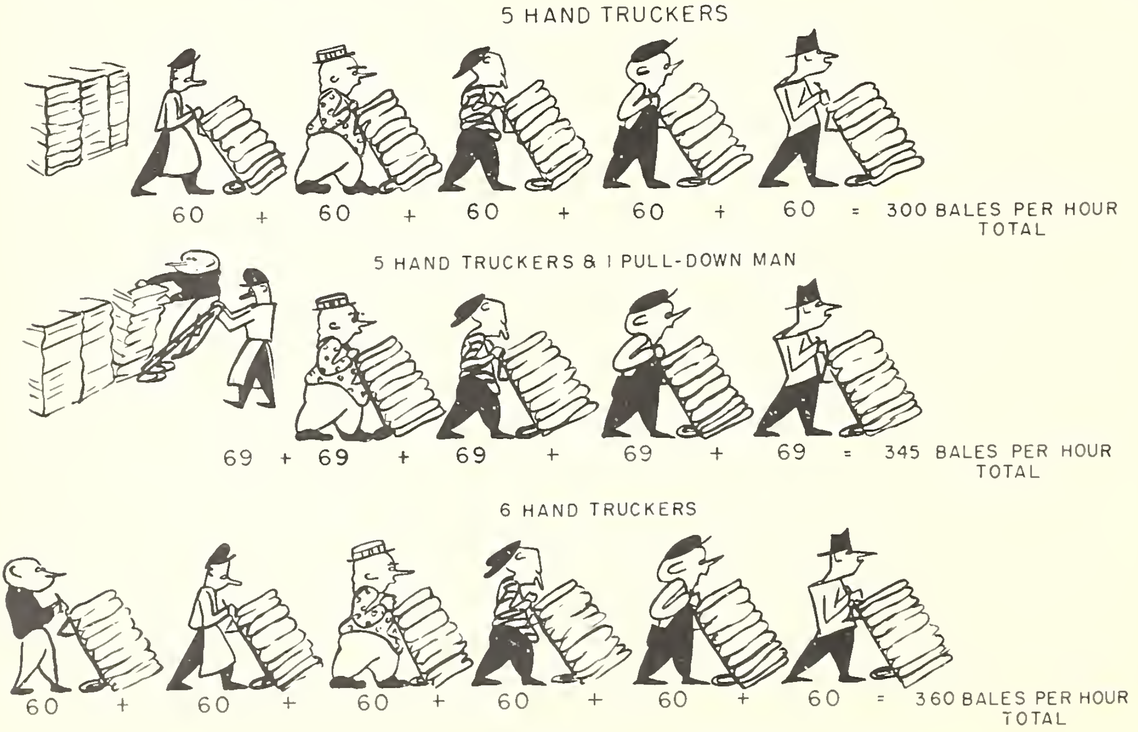
2. By using the clamp truck alone to build the entire stack, thus eliminating all waiting time, but requiring a longer period to complete the stack. This solution is more likely to result in the achievement of maximum efficiency.

Another example is illustrated in the operation of a tractor-trailer train system. The fact that the loading and unloading of tractor-trailer trains often require different times may cause an unbalanced operation. The result is that the crew--the loading or the unloading crew--which has the shorter handling time will remain idle on every trip for at least the amount of time by which its handling time is exceeded by that of the other crew. For example, if on the average 3 minutes are required to load a trailer train but only 1 minute is required to unload it, the unloading crew remains idle for 2 minutes more than it would otherwise be idle between train arrivals. In this case the time of the longer element--the loading operation—determines the minimum spacing in time between trains. This spacing applies, of course, throughout the transporting cycle. Therefore, efficiency is increased if the crew sizes and the duties of crew members are adjusted so as to cause the loading and unloading times to be equal. Again, these types of delays often may be avoided entirely by substituting for the tractor-trailer train system one or more clamp-truck carriers, where the machine itself performs the "loading" and "unloading," as well as the transporting of bales, and the problem of balancing does not arise.

Sometimes, when the size of the crew is changed, the problem is not so much to achieve balance as to preserve whatever balance had already been established. Changes in crew size are sometimes made to obtain an increased production rate. Whether a change in crew size is justified from the standpoint of efficiency, however, depends on the relation between the change in the crew size (input) and the change in the production rate (output). When an increase in crew size results in a proportionate (or greater) increase in production, the extra labor "pays its way." A less than proportionate increase would mean that the added labor did not

pay its way. Whether the increased output is proportionate to the increased labor costs depends on the tasks to which the new workers are assigned and on whether the changes involved result in improving, maintaining, or lessening the degree of balance already existing in the operation.

This principle can be demonstrated in an assumed case where five men truck cotton from one area to another, and the warehouseman wishes to speed up production by adding a pull-down man. The length of the haul is such that each hand trucker can pick up a bale, transport it to its destination, set it down, and return to the original starting point to pick up another bale in exactly 1 minute. This rate means that each hand trucker transports 60 bales an hour, and that all 5 hand truckers transport a total of 300 bales per hour. The time required for a hand trucker to pick up a flat bale on his hand truck without assistance is 16 seconds. When a pull-down man is used, this time is cut in half, or reduced to 8 seconds. (Although these are assumed times, they correspond closely to pick-up times observed in practice.) When the pull-down man is added to the crew, the complete cycle for transporting a bale is reduced by 8 seconds, or from 1 minute to 52 seconds. Since a bale can now be moved every 52 seconds instead of every minute, each hand trucker handles approximately 69 bales per hour. The 5 hand truckers assisted by the pull-down man now move 345 bales per hour instead of the 300 bales handled by the 5 hand truckers alone. It should be noted, however, that if the pull-down man were used as a hand trucker instead of as a pull-down man, he should himself be able to transport 60 bales an hour, which would raise the total bales handled in an hour from 300 bales for 5 hand truckers, or 345 bales for 5 hand truckers and 1 pull-down man, to 360 bales for 6 hand truckers.



In this example, the addition of a pull-down man results in a <u>less efficient</u> operation because the pull-down man when added to a crew of 5 hand truckers, in this particular operation, is not able to increase production enough to pay his way. Although he represents an increase in manpower of 20 percent, as a pull-down man he is unable to accomplish a 20-percent increase in production, which is necessary to justify using him in this capacity. His addition to the crew as a pull-down man <u>unbalances</u> an operation already in balance. To restore the balance, when a pull-down man is used, would require the use of 8 hand truckers rather than 5; or, the existing balance and efficiency could be maintained, and a proportionate increase in production obtained, simply by using an added worker as a hand trucker.

This example represents a very common situation in many warehouses. The use of pull-down men in hand-truck operations is widespread. In most cases a pull-down man increases labor costs without returning a compensating increase in production. The use of break-out men, set-up men, and other men, who "assist" workers in hand-truck and manual operations, usually falls in the same category. Although they usually increase the rate of production, they do so at the expense of efficiency and therefore at an increase in costs.

Where speed is not the primary consideration, there may be times when it is worthwhile to accept a <u>reduction</u> in the rate of production in order to obtain a more efficient use of labor. Under such circumstances, efficiency usually results from a reduction in crew size at some point in order to achieve a better balanced and smoother functioning operation.

<u>Decreasing Costs Principle</u>

<u>Equipment costs per hour of operation decrease as the number of hours the equipment is used increases</u>. As the number of bales that are handled by a clamp truck increases, the cost of owning and operating the machine can be spread over a greater number of hours of operation, thus lowering the per hour cost of handling. (Or, if one is interested in costs per bale, ownership and operating costs may be distributed over a greater number of bales, and a lower handling cost per bale would be obtained.) Obviously, there is some point below which equipment cannot operate profitably. For example, any lift truck or other machine must operate a certain amount of time each year or handle a certain number of bales or it will not have "earned its keep." Exactly how much time it must operate or how many bales it must handle are questions that must be answered on an individual warehouse basis and in the light of prevailing conditions.

These considerations also apply to the operation of the warehouse itself. A warehouse must operate at a loss unless it does a certain amount of business. The greater the volume of bales handled, the more the cost per bale for handling should decrease if capacity of the warehouse and its equipment is not exceeded.

Obviously, equipment does not have to be kept in operation full time to justify buying it. Certainly, in a highly seasonal industry such as cotton warehousing, far less than full employment of equipment is to be expected. Even part-time use of equipment during the cotton season may justify its purchase. For example, if a stationary beam scale could be converted into a mobile beam scale for $150, thus eliminating from the weighing operation 6 hand truckers who are paid $1 an hour, the new scale would pay for itself in only 25 hours of operation (assuming a comparable weighing rate). Likewise, if a clamp truck which costs $3,000 can be used so as to save the labor of 10 men when loading railroad cars, the machine would pay for itself (assuming the same wage rates) in 300 hours of loading time.

Increasing Costs Principle

The cost per bale for handling cotton increases as the volume of bales to be handled exceeds the capacity of the warehouse and of its equipment and labor. Although costs per bale decrease as the volume of bales handled increases, this decline in costs cannot continue without limit. Somewhere a point must be reached where if additional bales are handled, they can be handled only at a higher cost. Equipment, labor, and the facility itself, cannot handle an unlimited number of bales. No more than a certain amount can be handled in a given day, a week, or a season. If the capacity of any one of these factors is exceeded, the costs of handling a bale are increased.

Crowded and congested aisles and platforms are evidences of overtaxed equipment and facilities.

These conditions often arise long before the storage capacity of a warehouse is reached, since the capacity of a warehouse to handle bales in a specified period of time is not identical with its licensed or bonded storage capacity. In past years there have been several occasions when it became necessary to impose temporary embargoes on cotton shipments to certain warehouses or areas because of the inability of warehouses to unload and otherwise handle the bales received. Usually it was the capacity of equipment and labor that had been exceeded, rather than the storage capacity of the warehouse. However, under certain circumstances the storage capacity of a warehouse has an important influence on its ability to handle or move bales into or through the warehouse.

Many warehousemen, instead of attempting to avoid congestion and crowding, apparently are willing to live with it permanently. By placing stacks close together, leaving narrow aisles--or perhaps no feeder aisles at all--they deliberately set up conditions which make efficient use of equipment and labor difficult. In figuring the revenue that may result from the additional storage space thus made available, allowance should be made for the increased costs of handling which result from such practices.

Relative Advantage Principle

Economy in handling cotton is increased by assigning equipment and labor to operations in which each has the greatest relative advantage. Research has revealed that for most distances for which hand trucks are likely to be used, 2-bale clamp trucks have on the average a production advantage of about 4 to 1 over hand trucks for transporting bales, but when used for loading railroad cars, the clamp truck has a production advantage usually ranging from about 8 to 1 to 12 to 1 over hand-truck and manual methods. That is to say, for certain distances a clamp truck can transport as many bales during a given period of time as can 4 hand truckers, and it can load a railroad car at a rate equal to that of 8 to 12 manual workers. Therefore, when both a loading operation and a separate transporting operation must be performed simultaneously and only one clamp truck is available, the clamp truck should be assigned to the loading operation in preference to the transporting operation, since this results in the greater relative advantage. Obviously, it would be more economical to postpone the transporting operation until later when it, too, could be performed with the clamp truck.

It should be noted, however, that if equipment costs are high relative to labor costs for a certain plant, there might not be a cost advantage in using clamp trucks in place of hand trucks for transporting. A cost disadvantage is more likely to occur in operations in which the production ratio of equipment over hand trucks is as low as 2 to 1 or 3 to 1, but it could conceivably occur occasionally when the production advantage is considerably higher than 4 to 1. Therefore, equipment costs

as well as labor costs should be very carefully considered, at any particular warehouse, in determining whether or not bales should be transported by clamp truck or hand truck. Such consideration is especially important if the change in transporting methods would require the purchase of additional equipment. 9/

As an illustration: A particular warehouseman's use of a clamp truck is such that, when he depreciates its value over the period of use, and when he has taken into account annual hours of use, interest, taxes, and so forth, and has then added the hourly cost for fuel, servicing, and repairs, he finds that it costs him on the average of \$3 per hour of operation to own and use the equipment. For ease in calculation, it is assumed further that the wage rate for all workers (including the clamp truck operator) is \$1 per hour. In such a situation it is apparent that when the transporting advantage of a clamp truck is 4 to 1 over the hand truck, the hourly cost of transporting bales is \$4, regardless of whether hand trucks or clamp trucks are used, provided the bales are delivered at the same rate (the cost of owning and operating a two-wheel hand truck, which ordinarily is less than 1 cent per hour, has been disregarded in this comparison). This follows from the fact that if the same number of bales are to be moved in an hour by hand truck as are handled by a clamp truck (at \$3 per hour) and an operator (at \$1 per hour), four hand truckers (at \$1 each per hour) are required. If machine costs for transporting were greater than \$3, it would be cheaper to use hand trucks; but if machine costs were under \$3, and especially if they were no more than \$1 or \$2 per hour at this warehouse, transporting by clamp truck would represent a real saving over transporting by hand truck.

Preventive Maintenance Principle

Economy in handling cotton is increased if repairs to handling equipment, and necessary replacements of equipment parts, are anticipated. Breakdowns should be anticipated to as great an extent as possible and steps taken, by replacement of worn parts or by taking other precautions, to see that such breakdowns do not actually occur.

9/ If at any particular warehouse the substitution of clamp trucks for hand trucks in certain operations (transporting or otherwise) would make necessary the purchase of additional equipment, it is important that both ownership costs (depreciation, insurance, etc.) and operating costs (gasoline, oil, etc.) anticipated for the new clamp trucks be taken into account in comparing the costs of using machines with the costs of using hand trucks; if the substitution would simply mean that clamp trucks already on hand would be more fully utilized through occasional employment in such operations, the additional direct operating costs which would be required for such use of the machines, rather than total equipment costs, may be a more appropriate basis for determining whether the substitution would be economical.

The prevention of breakdowns is best accomplished through a sound preventive maintenance program. Preventive maintenance includes not only the proper care and servicing of equipment, but a systematic and regular inspection procedure to detect and eliminate possible sources of equipment failure. It is cheaper in the long run to make frequent inspections and minor repairs than to make the major repairs which are likely if minor repairs are neglected. The extra costs of repairs due to neglect of these factors is, therefore, an unnecessary cost included in the handling bill.

In addition to the costs of the repairs themselves the loss of the use of the equipment must also be considered. Frequently, this loss represents a larger cost than the repair bill. If, as a result of a breakdown, the use of a certain item of equipment is lost for a day on operations on which it would have saved the labor of 10 men, their total wages, at $1 an hour, would amount to $80, which would be part of the cost of the breakdown. Therefore, a proper preventive maintenance program should be regarded as absolutely necessary to holding handling costs to a minimum.

Equipment Replacement Principle

Economy in handling cotton is increased by replacing handling equipment with more efficient equipment, when the savings effected are large enough to pay for the cost of the replacement within a reasonable period of time. Obsolescense replacement relates to the replacement of equipment, before it is entirely worn out, with new and more advanced equipment. The replacement of a 2-bale capacity clamp truck with a 4-bale clamp truck is an example. A warehouseman should make such a replacement only if he is convinced that the new equipment would, within a "reasonable period of time," result in greater savings than would be obtained if he continued to use the old equipment. The time a warehouseman might consider "reasonable" for this purpose would vary according to circumstances. In this example, it might be the expected remaining life of the old equipment. For this period, the warehouseman would have to weigh the costs of owning and operating each type of equipment against the savings he would expect to get from each.

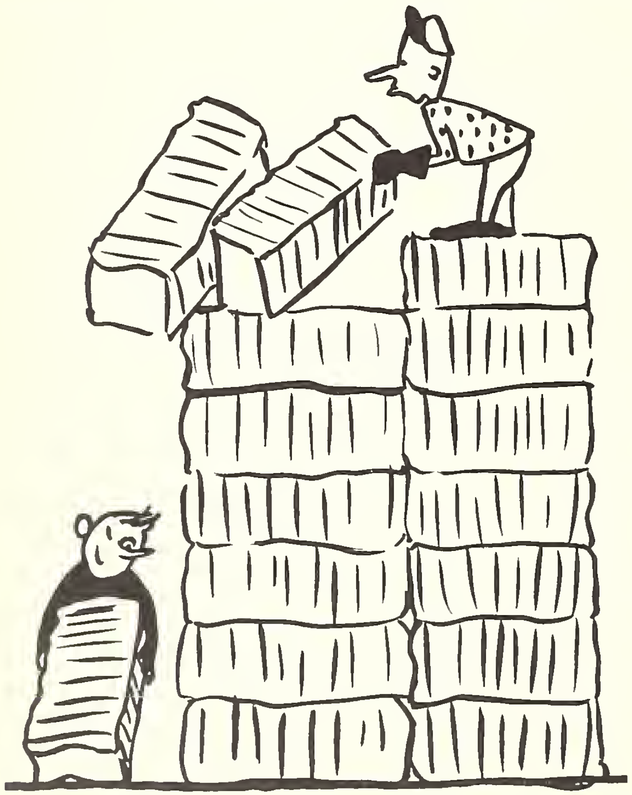
Before buying new equipment, the warehouseman should make certain that his present equipment is being used as effectively as possible, and that the new equipment would be even more effective. For example, a warehouseman who uses a standard or stationary cotton beam scale, and who is considering the purchase of a portable platform scale, should first determine whether he is making as effective use of his beam scale as possible. In this connection he may wish to consider the fact that for a relatively small additional expenditure his stationary beam scale may be converted to a mobile beam scale. This type of scale may appeal to a warehouseman if he has the necessary space, handles a sufficient volume of flat bales relative to compressed bales, and uses hand truckers in weighing. Another warehouseman may find that the simpler operation and the smaller scale crew required for use of the portable platform scale are sufficient to justify its purchase. In either case since the beam scale may, at little expense, be kept in service for years, the potential savings of the other equipment

must be examined carefully to determine which of the three weighing methods would result in the greatest net savings, taking into account the particular conditions under which the weighing is now done and probable developments in other equipment or methods for weighing. Whenever equipment is to be replaced, it should be replaced by the most efficient and economical equipment available.

In selecting new equipment, initial cost is only one of a number of factors that should be considered. The total savings possible over a period of time should be carefully considered in relation to both the ownership and operating costs of the equipment. A number of warehousemen have purchased small 1-bale fork trucks because of the relatively low initial cost, when the increased efficiency from a 2- or 3-bale clamp truck would have resulted in savings much greater than the difference in cost of the two machines.

Safety Principle

Economy in handling cotton is increased as working conditions are made safer. Protection of employees from possible injury is more than a humanitarian act; it is a means of lowering handling and operating costs. Personal injuries to a worker are of concern not only to the victim but to the warehouseman, who must lose the services of the worker, or employ another and perhaps less efficient worker to replace him until he can return to work. Also, payments and benefits to injured workers are reflected in liability insurance costs and in other expenses borne by the warehouseman.



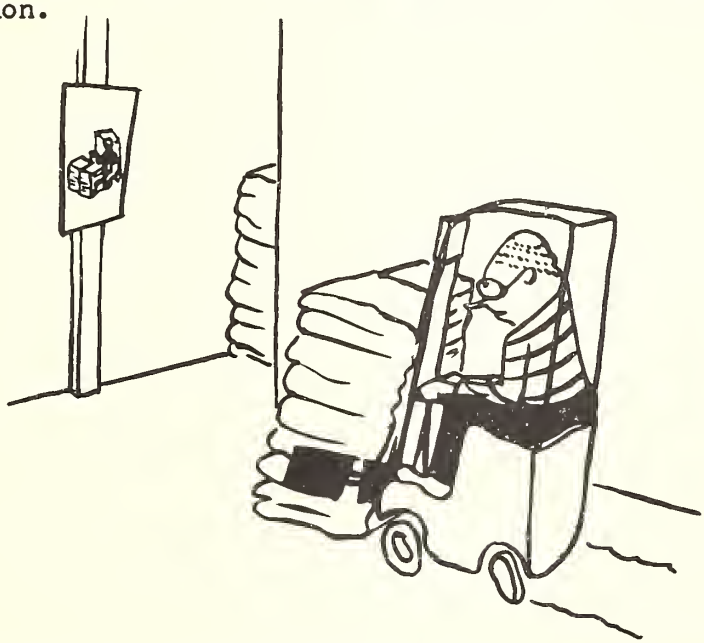
Many personal injuries incurred in the handling of cotton are often caused, or their severity increased, by the weight of the bales handled. A new employee, unless given proper instructions, may injure himself in trying to lift or otherwise move a bale.

A bale falling from the upper layers of a stack may crush a man or break his arm or leg.

Possibilities of injuries of these types may be minimized by using mechanical equipment in place of labor to the full extent possible. Such equipment is of special protective value when used in operations requiring the tiering of bales or in those involving the handling of bales already in tiers, such as the operations of loading, unloading, stacking, and breaking bales out of stacks.

The equipment used in handling operations should afford proper protection to the worker and to the equipment. For example: Clamp trucks used in tiering bales should be equipped with overhead guards; elevators should have safety gates; bridge plates should be strong but light, and when in use should be properly secured in position with a suitable locking device.

Since lift trucks and tractor-trailer trains used in cotton warehouse handling operations frequently involve much cross-travel, the operators should take special care in approaching aisle intersections and doorways, and in entering railroad cars, to avoid collision and possible injury to persons and equipment. A lift truck put out of commission through a collision, or from falling off a loading platform, is lost to production just as it would be lost if an engine overhaul were required--but for a much less valid reason. Wherever possible, aisles should be well marked at intersections, and obstructions to visibility should be removed. At some plants mirrors have been used successfully at doorways, intersections, and corners to warn a machine operator when equipment is approaching from another direction.



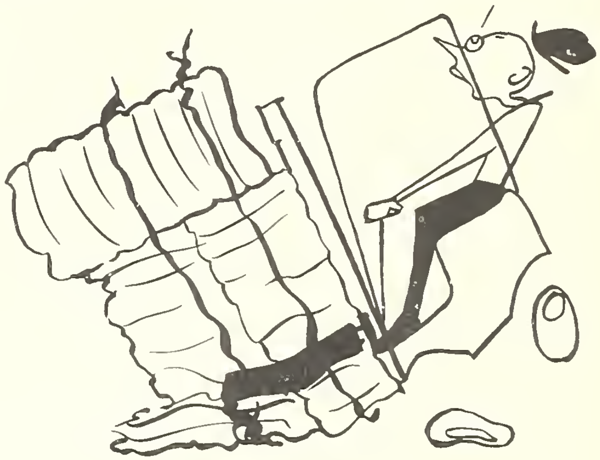
Care should also be taken to see that hand trucks, dunnage, cotton hooks, and other objects are not allowed to obstruct aisles, runways, and platforms, and thus prevent the safe and speedy passage of equipment.

Many cotton warehouses are very poorly lighted. A worker frequently is run down by a hand truck in an aisle so dark that neither he nor the hand trucker can see the other. Accidents of a more serious nature undoubtedly occur at times because lighting is inadequate.

Poor lighting may affect costs in other ways. Transporting may be slowed; more time may be required to "spot" bales because of increased difficulty in reading tag numbers and shipping lists; bales may be placed in wrong shipping lots; and errors may occur in reading weights. In fact, in order that bale weights may be read and recorded correctly, it is the practice in many warehouses to perform the weighing where the light is good instead of where the bales are located. This increases the distance the bales must be carried to the scale and thus increases the cost of the weighing.

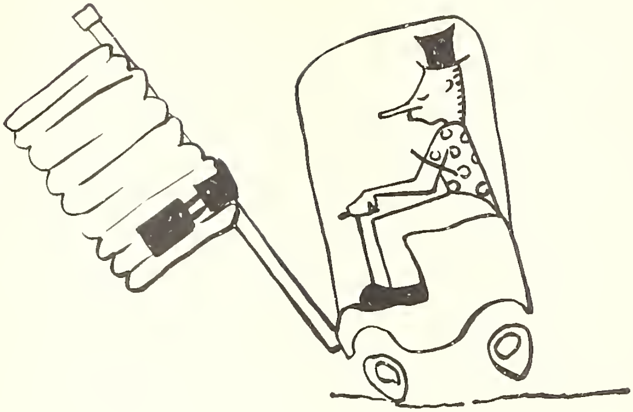
Safety in handling cotton may be increased if operators of the materials-handling equipment are properly instructed in the use of the equipment. If the warehouseman does not feel he is qualified to give this type of instruction, he may be able to obtain assistance from the nearest representative of his equipment manufacturer. Also, many such manufacturers have prepared small pamphlets or other materials covering proper care and operation of their equipment. Among the safety rules usually suggested to operators of lift trucks are the following:

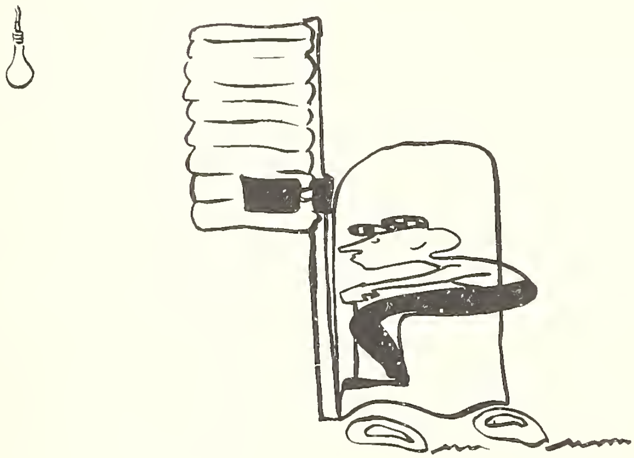
1. Don't exceed the rated capacity of the equipment.



2. Don't lift the load while traveling where to do so would create a safety hazard.

3. Lift bales only with the mast of the lift truck vertical or tilted slightly back—never with it forward.

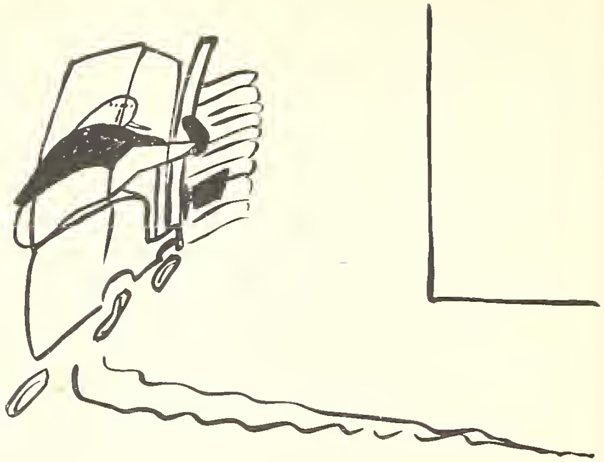




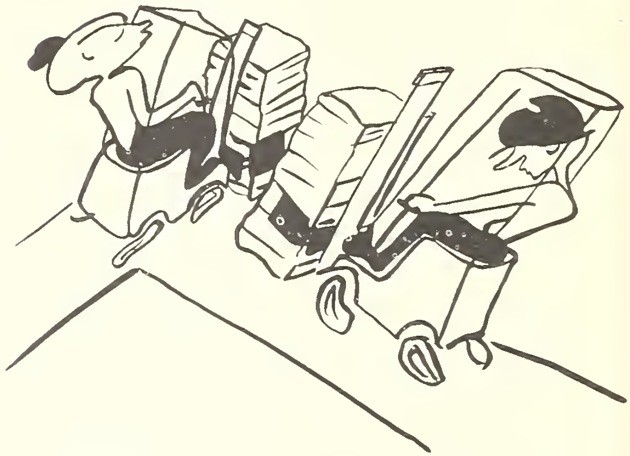
4. Never travel with the load lifted high.

5. Travel at a safe speed.

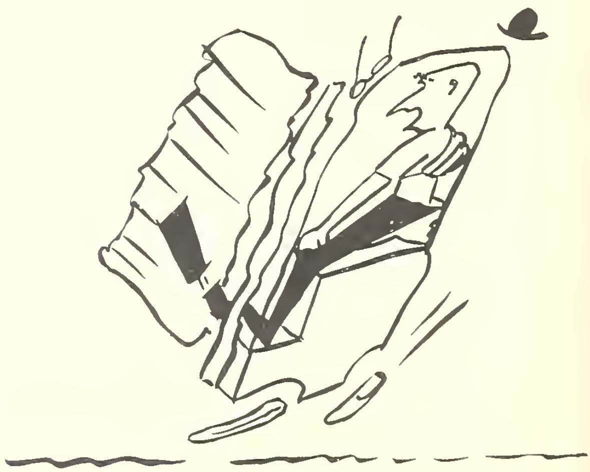
6. Go slow around corners.

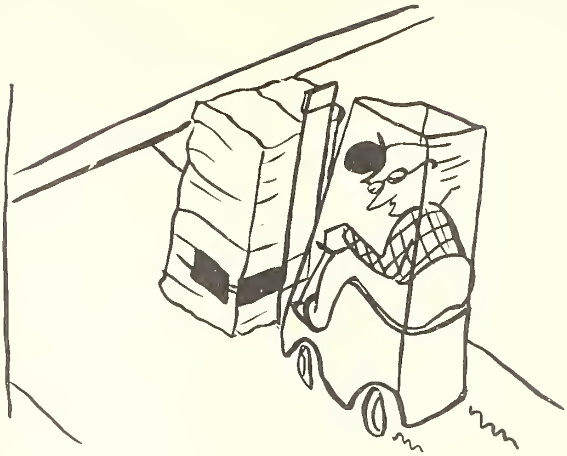


7. Be careful at intersections and blind corners.



8. Avoid sudden stops.

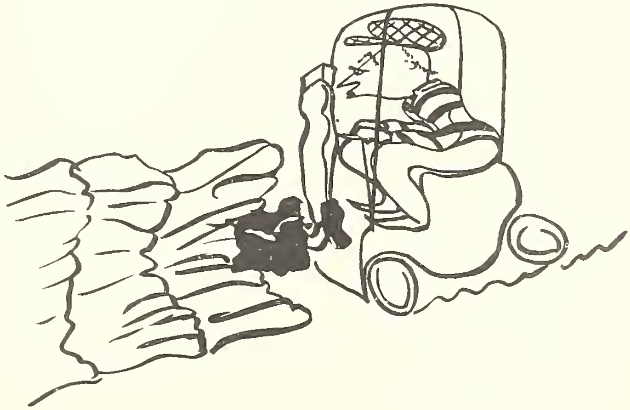




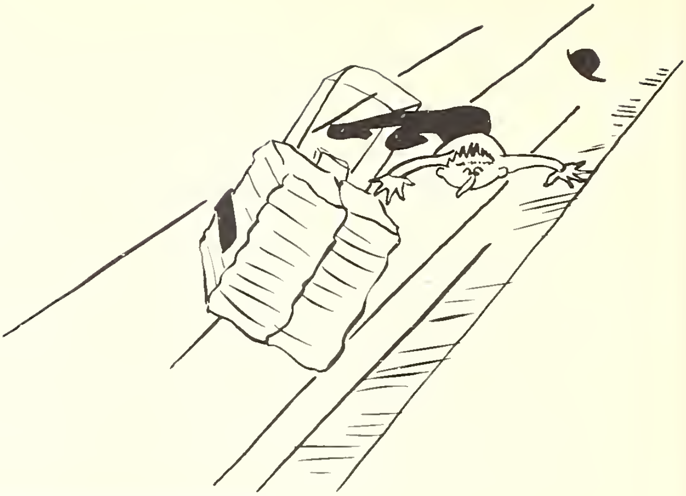
9. Watch overhead clearances.

10. When better vision is required, drive the truck backwards.

11. Don't butt bales with the clamps of the lift truck.



12. Keep clear of the edge of loading platforms.



Methods Review Principle

Maximum economy and efficiency in handling cotton can be maintained only if the methods used to perform various operations are subjected to a thorough review at regular intervals. This principle is one of the most important in methods improvement work.

When after study, experiment, and trial a particular method for performing a certain type of handling operation is proved superior to all other methods considered, the warehouseman should not assume that the adoption of this method permanently solves the problem of how to do the job most efficiently, and that he need give no further thought and study to this operation. Although the method may have been "adopted," some check-up or inspection may be needed to see that it is actually put into use, and that having been put into use, it remains so. It is always possible that lax supervision may allow a change in the adopted method—perhaps with no one realizing that this had happened—until it has become a different method. Moreover, conditions may change over a period of time so that a method once accepted as best becomes less efficient than other methods that might be used. Changes may occur in the nature of the operations performed, or technological advances and the development of new techniques and equipment may make the adopted method obsolete. To retain an obsolete method when more efficient and less costly methods are available is wasteful and expensive.

The best way to insure against retaining a handling method beyond its period of economic usefulness is to make sure that all methods are carefully reviewed at regular specified intervals. This review provides an opportunity for a fresh look at the method, for consideration of new ideas, and for reexamination of the method in the light of any change in conditions or handling requirements and in the light of any new equipment or techniques that may have become available. As stated previously: In the development of improved methods, eternal vigilance is the price of progress.

APPENDIX

Fundamentals of Time Study as They Relate to Methods Improvement

The term "time study" is broadly used to cover the various types of studies and analyses having to do with the improvement of work methods and the determination of standard times for performing specific jobs. It involves analysis of both methods and equipment used, and the development of the best methods that are practical. In this sense, a time study covers the use of any analytical tool, such as the charts mentioned on page 13, used to describe the nature of an operation. In a more restricted--and considerably less useful--sense, a time study is simply a means of determining how long it takes to perform each of the various elements in an operation.

Timing of Elements Important. A time study is conducted by an "observer," who records on an "observation sheet" time measurements and other pertinent information relating to the operation being studied. Although in conducting a time study an over-all time is obtained for a particular operation observed, the taking of an over-all time is not what is meant by making a "time" study. Over-all time provides, for certain purposes, a useful and convenient means of measurement, but from the standpoint of methods improvement, at least, time measurements are of greatest value only when they are in sufficient detail to show the times required to perform each of the various elements of an operation or cycle.

A time study should account for the way every moment of time is spent. One of the purposes of a time study is to reveal where time is being wasted in an operation so that steps may be taken to avoid such waste. The presence and amount of idle time in an operation cannot be detected by simply taking the over-all time; each element of the operation must be carefully observed, the elapsed time for performing each element recorded, and the occurences of waste time and the reasons for them especially noted. Time measurements of elements and of idle periods within and between elements are best obtained by means of a stop watch; however, in many cotton-handling operations much valuable information can be obtained through the use of an ordinary watch.

Leveling. The time required to perform an operation is influenced by the skill and effort displayed by those doing the work. The degree of skill and effort shown may differ from one operation to another. Therefore, before two methods or two operations can be compared with respect to time requirements, these differences among workers employed under the two methods of operations must be taken into account. This is done by a process known as "leveling." A leveled time is an observed time corrected for the worker's departure from normal performance. It represents not the actual elapsed time recorded, then, but the time that would be required if the worker (or crew of workers) performed at a normal pace. What level of performance

is to be regarded as normal, and the amount by which observed performances depart from normal, are determined by the time study observer. For example, the observer may decide that a worker (or crew) on one operation is working at, say, 80 percent of normal, and that another worker (or crew) on a different operation is working at a rate 10 percent above normal. An experienced observer is able to make these judgments with a very satisfactory degree of consistency. Less experienced observers may not always do so well. The general result of leveling, however, even when done by those with only limited experience, is substantially to improve the bases for comparisons.

Base time. From a series of many time measurements made of the same element, a selected average time for that element is determined. It is called a "selected" time because certain extreme time measurements, above and below the general range of the measurements recorded, are eliminated from consideration. As an example, times which have been increased because of the inclusion of avoidable delays should not be considered. The selected time value is then leveled to take into account the observed rate of performance. The time thus derived, after leveling, is known as the "base time" for the element. (In practice, all the elements of an operation may be combined before leveling is done.)

Cycle time. The sum of the base times for all elements in an operation cycle is, of course, the cycle itself (where a cycle is defined as the time required to perform all elements upon a single unit of product). However, when a series of identical cycles are repeatedly performed in sequence or otherwise combined to form an operation on a large number of units of product, as the weighing of several hundred bales during a day, it will usually be found that the average time per bale (if one should take the trouble to compute it) is somewhat larger than the cycle time. This is because of the presence in the operation of certain other time-consuming factors.

Wait or delay time. Among these factors, and one which especially characterizes cotton-handling operations, is the factor of idle or wait time--delay time, as it is often called. In many current types of cotton-handling operations a considerable part of the time spent on a job is wasted because it is spent in waiting rather than in working.

Much of the wait time in a handling operation is often avoidable, without regard to the method used in performing the operation; some of it is avoidable only if the method is changed; a small part of it is perhaps unavoidable by any practical means. Wait time between operations, such as the waiting of unloading crews between the arrivals of motortrucks bringing cotton to the warehouse, is especially difficult to control. Although this type of wait time is often a source of annoyance and considerable expense to a warehouseman, it is not part of the operation itself, and therefore will not be discussed here.

A delay caused by the worker himself, which could have been avoided by the exercise of ordinary care, is known as an avoidable delay. This

type of delay is not considered in determining the time requirements for a job.

A delay over which the worker has no control, such as one required to remove broken bands, secure torn bagging, or replace lost bale tags while an operation is being performed, is known as an unavoidable delay. In figuring time requirements for an operation a delay allowance to cover unforeseen interruptions of this kind should be made.

In many cotton-handling operations, because they are performed by a crew of men rather than by an individual operator, or because two or more operations involving the same group of bales are linked together, and therefore forced to be performed simultaneously, by the passage of individual bales from one operation to the next, another and unique type of "unavoidable" delay arises. These are the delays which result from the difficulty of synchronizing: (1) The efforts of individual crew members, in the first case; or (2) the varying potential production rates of different operations, in the second case. Paradoxical as it may seem, these "unavoidable" delays may often be avoided. They are unavoidable only in the sense that they are inherent in the method followed. Once a method has been selected, certain types of delays go with it. Many of these delays may be "avoided," or their frequency or duration decreased, by changing the method.

The delays and wait time inherent in a particular method should be included in the time requirements under that method. One of the principal problems in improving the efficiency of a handling operation is to discover the delays that are a natural result of the method used, and to attempt to avoid as many of these delays as possible by devising a better method.

When base times for complete operations have been increased sufficiently to provide for unavoidable delays, including those inherent in the method followed or the crew organization used, this may be as far as one needs to go in determining a time basis for cotton-handling methods that are to be compared for efficiency.

There may be some cases, in fact, where ordinary elapsed times may provide valid comparisons without the necessity of any adjustments for differences in performance of different workers or for inherent delays. A warehouse manager or foreman, in comparing a new method with an old method used within his own plant, where workmen with whom he is long familiar conduct the test operations, is not likely to run into any difficult problems of leveling. His own past experience with his workers will usually enable him to tell whether they are working at a normal pace, and if they are not, whether it would make any difference in his conclusions regarding the relative merits of the two methods. Similarly, by observation he may be able to tell whether the delay factor is important to the particular comparison he is making.

Personal and fatigue allowances. For certain purposes and in certain types of work, as for example a highly repetitive operation that is performed continually throughout the day without scheduled interruptions or rest periods, it is important that consideration be given to at least two additional factors that tend to increase further the time that on the average will actually be required for a given output. These factors are: (1) Time required for personal needs (personal allowance); and (2) time for enough rest and relaxation to permit the worker to maintain a normal level of performance throughout the day (fatigue allowance).

Standard time. When the base time computed for an operation has been increased so as to take into account delay, personal, fatigue, and other allowances that may be required, it becomes what is known as a standard time. The standard time for an operation is the average time that should be required day in and day out. It usually is the basis for setting incentive wages, production schedules, and so forth; it also is regarded as the most satisfactory basis for methods evaluation and comparison. Although in certain situations and for certain kinds of evaluations and comparisons of cotton-handling methods, base times--or base times plus delay allowances--would be satisfactory enough, it is important to understand how a standard time value is derived and how it is to be interpreted. For instance, it would be difficult for a cotton warehouseman to consider production rates of handling activities which continue over a sustained period of any considerable length without taking into account the necessary personal and fatigue allowances which enter into the determination of standard time. For such a purpose, standard times, rather than base times plus delay allowances, should be used for the operations concerned.

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